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1933-34

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This Report is printed on paper made in the Paper Pulp Section of the Forest Research Institute, Dehra Dun, from the bamboo *Dendrocalamus hamiltonii* (*kokwa*).

FOREST RESEARCH IN INDIA, 1933-34.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

Work was continued in accordance with the sanctioned programme. The day to day enquiries continue to increase and it has been necessary to confine investigations to matters of real scientific interest in connection with investigations already in hand or to matters which give some promise of being of economic importance. The President has noticed a tendency to saddle the branches of the Institute with enquiries which would take months to complete and when completed would merely be of academic interest. In these days of retrenchment such investigations are to be discouraged.

Further improvements were made to the museums which manage to attract considerable numbers of visitors. During the year approximately 15,000 visitors passed through the museums and the largest recorded number was 1,708 in March. The Museums are now kept open during the hours of daylight. Endeavours have been made to maintain the closest co-operation with provinces. It is for provinces to send us their problems and to tell us how we can help.

In the Silvicultural Branch, useful progress can be reported in all sections. The close co-operation in field work with the Provincial Research Officers referred to last year has been continued and still further development in this direction is being called for; it is to be discussed at a meeting to be held at Dehra Dun in October, 1934.

The results of the joint survey of management and regeneration problems for *Shorea robusta* were published in an illustrated Record and many of the recommendations have already been taken up in the provinces concerned. The all-India teak seed origin investigation in which eleven centres are taking part has been satisfactorily continued, although rather more difficulties were experienced than anticipated in obtaining the necessary fully stocked plots of different origins. The investigation

of methods of bamboo management (for *Dendrocalamus strictus* primarily) has also been prosecuted on a co-operative basis in five provinces; the Branch accepted responsibility for the initial work of the experimental plots and this has been put through with the help of the provincial staffs who will undertake future maintenance. This work has brought to fulfilment one of the objects of the Branch hitherto unattained, *i.e.*, the use of the Experimental Assistant in the field in assisting the Provincial staffs on special problems, especially those paralleled in several provinces.

The study of increment and mortality statistics for uneven-aged crops has been the subject of discussion and correspondence with several provinces, and by taking over the routine sample plot work of the year from the United Provinces, their field party was freed to take up this subject on a programme mutually agreed to be the most promising.

The practicability of measuring standing sample trees with the use of a light sectional ladder and a swing seat was amply demonstrated, both in the hills and plains, for conifers and broad leaved trees. This meets a need already felt in connection with permanent sample plots and should result in a significant improvement in the precision of the measurements obtained. European experience has shown that this need will be intensified with the passage of time as good sample trees become more and more difficult to find, and the increased importance attached to varying thinning procedure particularly calls for repeated accurate measurements on standing trees in the experimentally thinned plots.

The publication of a " stand table " to supplement the existing yield tables for *Shorea robusta* may also be signalised as a useful piece of work. Hitherto, it has been possible to predict the number of trees per acre of fully stocked forest of known quality, and their *average* diameter. The new tables add the expected range of diameter around this average value with the proportion or number per acre in each diameter class.

Extensive field work on experimental silviculture is now not provided for at the Research Institute, but such investigations as can profitably be undertaken there, above all the study of experimental methods, are being continued. Among other items, are one or two experiments which are repeated on as nearly identical lines as possible each year to determine the influence of seasonal variations, and that dealing with pre-monsoon planting of teak stumps has given interesting results which were published with a general account of a series of experiments on winter planting. The progress of height growth during the season has been under study for a number of common species for several years, and the accumulated data were analysed with a view to publication shortly; the differences from year to year are sometimes remarkable. Another small but interesting investigation was that on the effect of defoliation on the diameter and volume increment of young teak plantations.

A number of observations were recorded and experiments initiated on the question of root systems and root competition both as between trees of a crop and trees and grass or cover crops. One of these experiments involves a replicated series of plots of which very few yet exist in India. Several years must elapse however before definite results can be looked for.

In the Botany Branch Mr. Parkinson investigated further the species on the Bengal linear sample plots and continued his study of the Dipterocarpaceae. The usual additions and exchanges were made in the herbarium, and the Institute arboretum was still further enlarged. The investigation of Indian Peridermiums was brought a stage further by the publication of Dr. Bagchee's paper on *Peridermium himalayense*. A cultural study of wood rotting fungi is in hand and the investigation of the sissoo fungus continues.

In the Entomological Branch the outturn of publications issued or sent to press continues to increase,—thirty-nine items against twenty-five last year.

Field-work and transmission experiments with insects in research on the spike disease of sandal came to an end on termination of the special grant. A considerable quantity of evidence was accumulated that the disease is transmitted by insects and that a jassid bug, *Moonia albimaculata*, is a vector. This important achievement was not generally accepted as positively proved, and it is therefore a matter of regret that research had to be abandoned before unassailable scientific proofs could be presented.

The identification and ecological analysis of the sandal insect fauna continued and seven specialists furnished reports that added 297 species and 167 genera to the faunal list.

Measures were devised for the control of timber borers, marine borers and many groups of minor pests, which are acknowledged to have been successful.

Considerable progress was made in the investigation of the factors of natural control of teak defoliators as represented by prarasites and predators and the pests of trees and plants associated with teak.

A technique was evolved for tests of natural resistance, preservative efficiency and durability of timbers exposed to termite attack, and general measures for the control of termites in forests were published.

New investigations started include the borers of living bamboos, and the causes of the dying back of *champ* (*Michelia champaca*) in plantations.

About 58,000 insects were bred in the insectary and 287 new species were added to the Institute collection which now comprises 13,587 species.

In the Economic Branch a review of the year's working shows that a considerable amount of very useful research work was accomplished, and despite the heavy retrenchment to which the Branch was subjected two years ago, most Sections have settled down to the new conditions with remarkable tranquility and work has continued unabated, except for a reduction in the volume of the experiments done and a slowing down all round, which are unavoidable with reduced funds and reduced staff.

The Forest Economist toured round the sleeper depots of the Punjab in order to familiarise himself with the actual conditions of production and sale of sleepers, and the Inspector General of Forests toured with the Chief Engineer, North Western Railway, and the Timber Advisory Officer to the Railway Board, with a view to see for himself the service of the wooden sleeper in the line. A meeting of parties interested in the supply of coniferous sleepers was subsequently convened by the Inspector General of Forests to discuss problems connected with the supply of wooden sleepers which has somewhat clarified the situation and may lead to good. Partly as a result of the Inspector General of Forests' recommendation the treatment of deodar sleepers was sanctioned by the Railway Board which promises to add greatly to the diminishing serviceable life of this sleeper.

The work done by Dr. Kapur in connection with his new kiln-seasoning process is worthy of special mention. This new method of seasoning not only greatly reduces the consumption of steam and electricity, but shortens considerably the seasoning period, while at the same time producing seasoned wood of very high quality.

Another important feature of the year's working is the " fixation " of copper in conjunction with arsenic in wood for preservative purposes. The fixation of arsenic in wood has for many years been the aim of wood preservists and chemists throughout the world, but it was Mr. Kamesam of the Wood Preservation Section at Dehra Dun who ultimately achieved this. Mr. Kamesam has now gone one step further and has evolved a technique for fixing copper, in addition to, and in conjunction with, arsenic in wood for preservative purposes. If the new process, known as the Ascu process, fulfils all the claims made for it, the cost of wood preservation will be reduced enormously while the preservation of the wood should be improved.

The work done by Mr. Chowdhury in the Wood Technology Section and by Mr. Bhargava in the Paper Pulp Section is also worthy of notice, and it can be said of the Economic Branch in general that it has maintained its efficiency throughout the year and has kept up the high standard of work expected of it.

The Institute took part this year in the All-India Industrial Exhibition which was held in February-March, 1934. An Upper Grade Assis-

tant was in charge of the arrangements. He went with the exhibits to Delhi and stayed there for a week to answer enquiries. The average daily attendance at the stall was 909, but the number of serious enquiries received was far below expectations. Nevertheless the Forest Research Institute stall served its purpose in bringing to the notice of the public the fact that they could always apply to the Forest Research Institute for information and advice on all forest matters, and this is proved by the greater number of enquiries received after the exhibition. In these days of competition the Forest Department must advertise its products and must keep them before the eyes of the public. Propaganda in any form is good, but propaganda at exhibitions is now-a-days recognised as one of the best way to bring facts to the notice of potential purchasers.

The work in the Chemical Branch was chiefly confined to the general study of the chemistry and commercial uses of minor forest products. The bark of *Actinodaphne hookeri*, known to be a specific for diabetes in Indian medicine, was found to contain an alkaloid named 'actinodaphnine'. Its chemical constitution has now been determined and it has been found to belong to the aporphine group of alkaloids. It is of interest to find that the probable active principle of the tap root of *Bombax malabaricum*, known as "musli" in the Indian system of medicine and reputed to possess excellent tonic properties, is a cephaline like phosphatide, which rarely occurs in vegetable tubers. Rotenone, the active principle of *Derris elliptica* and *Caracca verginiana* roots, has become very popular as a valuable insecticide all the world over. Its demand in India is likely to increase in the near future hence the occurrence of *Derris elliptica* roots, containing 0·8 per cent. of rotenone, in Dibrugarh, Assam, may be considered as an important find, since it opens up the possibility of its cultivation in that locality, thereby ensuring a regular supply of roots of high rotenone content. Recently a new detergent consisting of sodium lauryl sulphate, has been put in the market under the commercial name of "Gardinol W. A." or "Orvus" and its demand is on the increase. The raw material for this preparation is trilaurin. A search for the sources of this raw material revealed that it occurs to the extent of 96 per cent. in the fat from the seeds of *Actinodaphne hookeri*, and 70 per cent. in the fat of *Litsæa zeylanica* seeds, and to a lesser degree in the fat from the seeds of *Cinnamomum camphora*. Oak acorns are at present a waste product of the forest but in America the acorns are considered to be a good feeding material both for poultry and cattle. The food value of Indian acorns has been found to be good. The oil content is low but it is a thin yellow oil of good quality consisting mainly of oleic and lignoceric glycerides. Under the President's direction a co-operative study of the semi-commercial cultivation of certain minor forest products chiefly medicinal plants has been started.

Mr. C. G. Trevor took over the post of Inspector General of Forests and President, Forest Research Institute and College, from Mr. A. D. Blascheck who proceeded on leave preparatory to retirement. Mr. Trevor wishes to thank the staff of the Institute for their loyal co-operation in the advancement of forest research and to record his appreciation of the work done by all branches in spite of the great reduction in their compliment due to retrenchment. Details of the work done in the several branches, list of publications, and statements of staff and expenditure are given in the chapters and appendices that follow.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

Two notes on experimental work carried out at the Institute were published in the *Indian Forester, viz.*—

The effect of thinning out multiple shoots on young root stocks, *Indian Forester*, Volume LX, No. 1, January 1934.

Seeding of *Anogeissus latifolia* (Experiment 44), *Indian Forester*, Volume LX, No. 2, February 1934.

Another on teak defoliation was written up for publication during the year. An account of the experiments made on Winter planting was submitted for publication as an *Indian Forest Record.*

(ii) Natural regeneration.

The study of annual seed production and fertility of individual trees of *Anogeissus latifolia* was continued for the sixth year. The tests have not borne out the suggestion that a drought year is followed by a good seed year for this species in North India.

Seed crops from individual trees of *Shorea robusta, Pinus longifolia* and *Terminalia tomentosa* were again recorded. 1933 was a fairly good seed year for the former two species but *Terminalia tomentosa* produced no seed—these records must be continued several more years before analysis can be profitable.

(iii) Investigation on seeds.

(*a*) *Seed weighments and germination tests.*—During the year 112 weighments were made including 22 species for which no previous records were available.

(*b*) *Effect of size of seed on germination and growth of seedlings.*—The experiment was again repeated with teak in 1933, confirming the previous conclusion that the greater the size, the better the results.

(*c*) *Seed storage.*—Five species were added to the list under investigation, *viz., Terminalia arjuna, Dalbergia latifolia, Chickrassia tabularis, Terminalia chebula* and *Acacia modesta.*

For *Acacia catechu* and *Bombax malabaricum* stored in sacks, initial germinative capacity of 67 and 52 fell to 1 and 0·7 after one year, while stored in sealed tins, the figures were 25 and 36 respectively. *Cinnamomum camphora* with initial germinative capacity of 41 again gave 41

after storing for one year in sacks, while stored in a sealed tin, the capacity fell to 18, a rather unusual finding needing confirmation. After one year's storage, *Schleichera trijuga* and *Melia azedarach* shewed the same germinative capacity in sealed tins and sacks as their respective initial values, *i.e.*, 13 and 65 respectively.

(iv) Investigations on seedlings.

The morphological seedling studies as reproduced in Troup's *Silviculture of Indian Trees*, were completed for 8 species, *viz.*, *Acacia sundra*, *Buxus sempervirens*, *Diospyros ebenum*, *Saccopetalum tomentosum*, *Litsaea polyantha*, *Machilus gamblei*, *Sterculia foetida*, and *Stereospermum chelonoides*.

14 others were partly done, *viz.*, *Alstonia scholaris*, *Betula cylindrostachys*, *Boehmeria rugulosa*, *Bursera serrata*, *Cullenia excelsa*, *Dillenia pentagyna*, *Eugenia gardneri*, *Lagerstroemia parviflora*, *Nauclea excelsa*, *Pterocarpus macrocarpus*, *Sapium baccatum*, *Tecoma undulata*, *Turpinia pomifera*, and *Tsuga brunoniana*.

The experiment on the effect of burning back *sal* line sowings was continued another year, making the fourth and third year for the two replications. Comparing the results after three successive burnings, it is found that in both experiments the burnt sets have dropped about 10 per cent. behind the unburnt controls in average height, though after two burnings only they were equal or even somewhat superior. Cutting back would appear to confer a definite but slight benefit as regards height. The vitality of the 3 and 5-year old seedlings used in this experiment is very great and the three burnings have only resulted in 12 per cent. mortality as compared with 2 per cent. in the controls, 12 per cent. being quite unimportant in natural regeneration or line sowings. The fourth burning has proved as expected definitely detrimental, the stem height having now approached the limiting height attainable in one season's growth, *i.e.*, 5 to 6 feet. The controls take over a very significant lead, whilst the burnt plots only regain their original height cutting back again appearing slightly advantageous.

(v) Investigations on trees and crops.

(*a*) *Seasonal course of height growth.*—The necessary compilation work and detailed analysis have been done with a view to publishing the results for important species which have been under study for several years. Detailed correlation with climatic data does not yet appear possible.

The year under report has been conspicuous by the extremely poor growth for all species under study, the most probable cause being the exceptionally cool weather.

(*b*) *Phenological data.*—Observations were continued on fourteen species. Preliminary compilation work has been done, but detailed analysis remains pending.

(*c*) *Inheritance of individual characters.*—Seed of figured *Terminalia tomentosa* was received from South India and raised in pots for planting out in the rains of 1934.

(*d*) *Inheritance of climatic race characters.*—Work was completed with the All-India teak seed origin investigation. All the 11 origins have been planted in ¼ acre plots in the Experimental Garden.

With *Acacia catechu*, the Burma and local origin plots now begin to differ clearly in colour of foliage—the Burma being light yellowish green and the local dark green—and in bark, the local origin being still smooth at 3″ d. b. h. whilst Burma is already fissured at 2″ d. b. h.

(*e*) *Inheritance of physiological race characters.*—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture are being kept under observation.

(*f*) *Soil Quality Class indicators.*—The quadrats in plantations of different species in the Demonstration Area were continued and the mapping methods improved. Invasion of *Imperata arundinacea* and *Ageratum conyzoides* is the striking feature of the year.

(*g*) *Congestion in bamboo clumps.*—An unexpected insect attack affecting almost all culms of 1933 prevented initiation of the intended experiments. The work is expected to be taken in hand in the rains of 1934. The experiments laid out in the United Provinces, Punjab, Bihar and Orissa, and the Central Provinces primarily for optimum bamboo management are expected to throw light on this problem also.

(*h*) *Root competition.*—A small scale investigation in replicated plots was initiated in *sal* and *chir* to study the effect of root competition of the suppressed and dominated stems on the dominant trees in a crop.

(*i*) *Thinning in young plantations.*—Two sets of plots were laid out in a 1925 *chir* plantation, one to determine optimum thinning intensity, and the other the best age at first thinning ; this work is expected to be more valuable from the point of view of determining the best experimental method, than from the immediate results, as the pine is not growing under conditions natural to it.

(vi) Artificial Regeneration.

The weather conditions affecting results were exceptional in that good rainfall was experienced in the 1932-33 winter and the 1933 hot weather, and the 1933 monsoon was also good. The results are shown in good survival but exceptionally slow growth, the low temperature and lack of sunshine throughout the growing period being perhaps the more immediate cause of the latter.

The 1933 monsoon broke on June 18th and was strong and well distributed till late in September.

The 1933-34 cold weather was also marked by normal rainfall but severe frost.

(*a*) *Line sowings.*—Various species were tried but the results were very poor probably owing to excessive and continuous rain. *Lannea grandis*, *Eugenia operculata* and *Terminalia chebula* sown in 1932 continue to develop satisfactorily.

(*b*) *Rains entire transplanting in the open.*—The following species were tried in 1933, the survival percentage at the end of the year being given in brackets. *Machilus gamblei* (83), *Garuga pinnata* (90), *Cassia siamea* (61), *Pterocarpus marsupium* (87), *Soymida febrifuga* (95) and *Lannea grandis* (98); until the plants have got over a dry season no practical conclusions can be drawn.

The following results were obtained at the end of second growing season with species tried in 1932, the figures giving survival per cent. at the end of the first and second seasons respectively.

Chloroxylon swietenia (84—0 per cent.), *Lannea grandis* (90—71 per cent.), *Carallia integerrima* (83—0 per cent.), *Eugenia operculata* (98—74 per cent.), *Schleichera trijuga* (5—0 per cent.), *Pterospermum acerifolium* (91—24 per cent.), *Stereospermum suaveolens* (86—70 per cent.), *Mallotus philippinensis* (78—28 per cent.), *Erythrina suberosa* (73—49 per cent.).

The failure of *Chloroxylon swietenia* and *Carallia integerrima* is ascribable to frost.

(*c*) *Rains entire transplanting in cleared lines.*—The following species were put out in 1933, the survival per cent. at the end of the year being given in brackets.

Schleichera trijuga (76 per cent.). *Cassia siamea* (39 per cent.), *Machilus gamblei* (98 per cent.)

For the species tried in 1932, the following figures shew the fall in survival per cent. during the second growing season. *Lannea grandis* (59 to 47 per cent.), *Carallia integerrima* (76 to 40 per cent.), *Eugenia operculata* (96 to 94 per cent.), *Schleichera trijuga* (35 to 25 per cent.), *Pterospermum acerifolium* (99 to 75 per cent.), *Erythrina suberosa* (29 to 10 per cent.), *Mallotus philippinensis* (62·5 to 60 per cent.).

(*d*) *Winter transplanting in the open.*—In December 1932 six species were put out and the survivals in December 1933 were found to be :—

Chloroxylon swietenia (5 per cent.), *Lannea grandis* (47 per cent.), *Soymida febrifuga* (26 per cent.), *Mallotus philippinensis* (0 per cent.), *Litsaca polyantha* (0 per cent.), and *Eugenia jambolana* (0 per cent.).

The high mortality is due to frost immediately after planting in December 1932, and it will be noted that only the deciduous species survived.

Three species were added in January 1934, *viz.*, *Pterospermum acerifolium*, *Terminalia myriocarpa* and *Terminalia arjuna*.

(*e*) *Winter stump planting in the open.*—In December 1932 six species were put out, and the survivals in December 1933 were recorded as :—*Acacia arabica* (0 per cent.), *Anthocephalus cadamba* (0 per cent.), *Garuga pinnata* (0 per cent.), *Erythrina suberosa* (84 per cent.), *Bauhinia retusa* (74 per cent.), and *Bauhinia variegata* (64 per cent.).

The stumps of the first three species were killed outright by frost immediately after planting in December 1932, the failure of *Garuga* being rather unexpected.

The following species are added during December 1933 :—*Cedrela toona*, *Celtis tetranda*. *Stereospermum suaveolens*, *Eugenia operculata*, and *Ougeinia dalbergioides*.

(*f*) *Rains stump planting in the open.*—The following ten species were put out in July 1933, the survival per cent. at the end of the year being given in brackets.

Grewia elastica (97 per cent.), *Olea glandulifera* (57 per cent.), *Terminalia chebula* (97 per cent.), *Xylia xylocarpa* (66 per cent.), *Eugenia operculata* (100 per cent.), *Ougeinia dalbergioides* (76 per cent.), *Shorea talura* (91 per cent.), *Erythrina suberosa* (93 per cent.), *Acacia arabica* (76 per cent.) and *Garuga pinnata* (98 per cent.).

Of the species put out in July 1932, *Albizzia lebbek*, *Cedrela toona* (both 100 per cent.) proved well suited for stump planting, *Bauhinia variegata* (83 per cent.), *Adina cordifolia* (77 per cent.), *Celtis tetranda* (84 per cent.), *Schleichera trijuga* (80 per cent.) were satisfactory, *Phoebe lanceolata* (64 per cent.), *Acacia catechu* (59 per cent.) fairly satisfactory, *Aleurites fordii* (42 per cent.), *Pterospermum acerifolium* (39 per cent.) poor, *Bauhinia retusa* (36 per cent.) and *Pistacia integerrima* (2 per cent.) unsuited. The figure in brackets is the survival per cent. at the end of the second growing season. The results are in keeping with general experience as reported in *Indian Forest Records*, Vol. XVI, Part VI.

(*g*) *Rains stump planting in cleared lines.*—*Amoora wallichii* and *Ougeinia dalbergioides* were put out in July 1933, survivals in December 1933 being 28 per cent. and 17 per cent. respectively.

Of the 1932 trials, the following survival percentages were recorded at the beginning and end of the second year : *Cedrela toona* (98—98 per cent.), *Albizzia lebbek* (96—87 per cent.), *Bauhinia variegata* (96—95 per cent.), *Aleurites fordii* (97—41 per cent.), *Pterospermum acerifolium*

(86—80 per cent.), *Phoebe lanceolata* (100—98 per cent.), *Schleichera trijuga* (96—92 per cent.), showing good results for all species except *Aleurites*.

(*h*) *Storage of stumps before planting.*—250 teak stumps made on 5th July 1933 were planted in comparable lots of 50 stumps after an exposure of up to 21 days to sun, rain and wind, in a heap on a cement floor; it must be remembered that there was more or less rain on 17 of the 21 days. At the end of the growing season the survival per cent. was 100, 100, 100, 86, and 76, and corresponding average height 7·9″, 7·7″, 7·0″, 6·5″ and 4·9″, for stumps exposed for 0, 5, 9, 15, and 21 days respectively, confirming earlier conclusions as to the exceptional vitality of teak stumps.

(*i*) *Early planting of stumps without irrigation.*—Teak stumps were planted fortnightly from 6th February to 20th June 1933. There were a few casualties on the earlier dates, but survival is virtually 100 per cent. throughout. This year, however, although every earlier set had a better average height at the end of the season than the June control, the differences are not great, being 4″ at the most, but expressed as a percentage (41 per cent.), they are appreciable and some are mathematically significant.

This experiment has been carried out annually since 1930 and the tentative conclusion drawn that early planting depends for its success less on past and current rainfall which is known, than on an early break in the monsoon which cannot so far be predicted.

(*j*) *Comparison of nursery stock and natural seedlings.*—In 1932 *Eugenia jambolana* jungle transplants were compared with two sets of nursery transplants, one being dug up from the nursery bed at the same time as the jungle plants and the other immediately before planting. At the end of the first growing season no significant difference was found between the three sets either in height growth or survival per cent., but it is probably significant that at the end of the second growing season the survival per cent. for the two nursery lots was reduced from 90 per cent. to 75 per cent. while for the forest lot it fell from 90 per cent. to 52 per cent., there being again no significant difference in height.

(*k*) *Comparison of nursery and forest stumps.*—*Eugenia jambolana* was tried in 1933. At the end of the growing season for both the lots, survival per cent. was found to be 100 with no significant difference in development.

(*l*) *Comparison of sowings, transplants, and stumps.*—It is difficult in this investigation to ensure comparability but the following is the record of observations at the end of second growing season for the four species tested in 1932.

Gmelina arborea.—Survival similar throughout but sowings with much lower height than entire transplants and stumps, the two latter being equal.

Tectona grandis.—Entire transplants were mostly killed outright by frost, stumps all escaping and shewing twice the average height growth.

Acacia catechu.—Entire transplants and sowings with equally high survival and height, stumps shewing only half the survival per cent. but a 50 per cent. better height.

Bauhinia variegata.—Survivals very high by all three methods, but average height dropping from sowings to stumps to entire transplants.

(*m*) *Araucaria cunninghamii plantation.*—The small plantation though a good deal damaged by hail at the beginning of the year, is doing well, having reached an average height of about 3'-6" with no casualties.

(vii) Nursery work.

The severe hail storm on the 19th March 1933 destroyed most of the seed crop on the trees particularly in the Dun Valley, and hence the seed of many species was either unobtainable or defective.

Stock was raised for various species for use in the Experimental Garden and some experiments were carried out, *i.e.* :—

(*a*) *Manuring of nursery beds.*—The results obtained up to 1932 inclusive were published by Mr. Deogan (*Indian Forester*, 1933, pages 292-301). The relative value of farmyard, artificial farmyard and green manures were again tested with teak in 1933, the results being in general agreement with the earlier work. *Crotalaria juncea* was used as green manure but the growth was only slightly superior to the unmanured control. The plots treated with artificial farmyard manure were unfortunately defoliated and the heights attained probably do not reflect the full value of the treatment.

(*b*) *The effect of nursery bed shades on soil temperatures during cold weather.*—This investigation was undertaken to ascertain whether the losses experienced from frost were due more to low soil temperatures than to air temperatures. Beds shaded during the night only were compared with beds shaded day and night, and unshaded beds, temperatures being read soon after dawn and at 2 P.M. daily at depths of 3" and 12". The results bring out very clearly the value of night shading. At 3", the average early morning temperatures for December-February were 47°F. and 52°F. for the night-shaded and unshaded beds and this effect is partly carried over to the afternoon when the unshaded bed

remains 2° colder. At 12″ the night-shaded beds remain some 4° warmer day and night. On the other hand, the bed shaded day and night shewed the same minimum as the completely unshaded bed, the effect of lower day temperatures under shade not appearing to be carried over to the night, which was unexpected.

(viii) Miscellaneous.

(*a*) *Effect of defoliation on diameter increment of teak.*—This investigation was taken up in consultation with the Entomologist to obtain statistical data under controlled conditions. Comparable sets of trees were defoliated by hand 2 or 3 times during the 1932 season and again in 1933, and compared with the untreated control. An epidemic attack by the leaf skeletoniser necessitated spraying the controls to minimise the attack on them. The defoliated trees produced a partial new flush of leaves late in 1933 and have unfortunately mostly been killed by frost. The results of this work are being published.

(*b*) *Methods of working bamboos for maximum sustained yield in quantity and value.*—The experimental plots laid out last year in the Punjab (Hoshiarpur division) and in the United Provinces (Lansdowne division) were reinspected and the varying treatments decided on actually applied during the 1933-34 cold weather ; both these sets which had been laid out by the Experimental Assistant, were visited by the Silviculturist with the local Divisional Forest Officer, and passed for handing over to the province for maintenance. The Experimental Assistant, Mr. Deogun, had also laid out similar sets of plots in collaboration with the Provincial Research Officers in Bihar and Orissa, the Central Provinces and Madras, thereby completing the initial work under this project. If maintenance is now adequately provided for, valuable data should be available in a few years' time, and this is considered one of the most important pieces of work accomplished in the season under report.

(*c*) *The All-India teak seed origin investigation.*—The collaborating Provinces and States all report progress with this investigation though it has proved much more difficult than could have been anticipated to get the requisite plots fully and evenly stocked. The Silviculturist was able to visit the plots in all the five S. India centres and discuss their further treatment with those in immediate charge. The differences in behaviour between the several origins under trial are even more marked than expected and the differences in appearance, particularly as between the Burma origins and the rest, are very obvious. Perhaps the most outstanding feature so far is the excellent results with Travancore seed which germinates very quickly and profusely, and shews excellent early development in most centres which have included it in their series.

(ix) Reclamation and afforestation.

The year under report has been a fateful one for the teak in the Demonstration Area as a number of calamities befell this species. The new flush of leaves had hardly appeared after recovery from frost in 1932-33 cold weather when on the 19th of March, a severe hail storm destroyed the tender shoots and in a good many stems forking resulted. The year was an exceptionally cool one—no month from November 1932 till October 1933 being rainless—with the result that the growth was extremely slow throughout. In the third week of September 1933 a sudden and severe attack of *Hapalia machaeralis* completely skeletonised the leaves throughout the plantation. About 40 per cent. of the plants so attacked came, late as it was, into new leaf, but the leaves were unable to grow more than one quarter their full size and the severe frost of 1933-34 winter killed the stems back to ground level, and has actually killed a large proportion outright, so that attempts to grow this species as a pure crop in this locality will be dropped.

(*a*) *Sal Working Circle.*—A total area of 3 acres was sown with Hoshiarpur, Haldwani and local origins. Frost damage in *sal* too was exceptionally severe.

(*b*) *Pinus longifolia.*—Casualties were replaced over 6 acres with Nainital, Hazara, Rawalpindi, Lansdowne, Chakrata and local origins. The year's growth was generally very poor.

(*c*) *Rosewood Working Circle.*—The 1932-33 and 1933-34 frost has killed back a good many plants and is apparently one cause of a witches' broom formation in the crowns. The future of this species also seems doubtful.

II.—STATISTICAL WORK.

(i) Yield Tables.

The multiple yield tables for *Cedrus deodara* prepared last year giving crop values for different grades of thinning were published as an *Indian Forest Record.* They make a formidable array and helpful criticism is hoped for to permit of subsequent improvements.

The provisional yield table for *Quercus incana* gave a great deal of work as various lines of attack that had appeared promising during the preliminary investigations, proved to be much less satisfactory on further examination and test. A table has been compiled and is in the Press, but it leaves much room for improvement, and it is to be hoped that a fairly early revision will become possible.

The stem distribution data required to supplement the published yield tables for *Shorea robusta* were worked up and published as an *Indian Forest Record*. This makes it possible to determine the average proportions or numbers of trees of different diameter classes which go to form a crop of given crop diameter, information which is frequently needed in divisional and working plan practice.

All-India teak yield tables have still to be compiled though the Nilambur tables continue to provide a useful standard. Tables have recently been published in Java in metric units and a form differing from Indian standards. With the author's permission, these are being converted to English units and the standard Indian form, for comparison with Indian data.

The trials with a sectional ladder for the measurement of standing sample trees were continued in the Kumaon hills mainly on *Pinus longifolia*, in co-operation with the United Provinces sample plot field party for whom the large sample trees were measured which were not available for fellings. The results were considered quite satisfactory, and an account was published as *Forest Bulletin* No. 82.

The routine remeasurement work due in the Dehra Dun and Saharanpur divisions was later undertaken by a Research Institute field party which demonstrated the practicability of the method in standard practice. The possibility of the derivation of the required measurements from photographs taken for the purpose is still under examination.

As usual, work on standard sample plot files occupied much of the time of the computing staff, but owing to the amount of special work in hand, the number disposed of, 180, was rather less than usual and was actually 142 less than the number received from the provinces.

The total number of sample plots now maintained is 1,475 of which 322 are in Burma and 1,153 in the rest of India. Additions during the year, totalling 50 (nett). are mostly among the species for which yield tables have not yet been published, many of them being in young plantations just big enough for laying out plots—thus several for *Terminalia myriocarpa* and *T. tomentosa*, and 4 for *Michelia champaca*. No new plots were laid out by the Forest Research Institute during the year.

(ii) Volume Tables.

No field parties were sent out during the year for the collection of volume table data. There is a lot of work still to be done in this direction, but it can be effectively done by the divisional or provincial research staffs, provided care is taken to ensure work on the right lines. Assistance was given to provinces in compilation work but no new tables were published.

(iii) Miscellaneous work.

Field data collected in the Central Provinces for determining the best rotation for *Cleistanthus collinus* in coppice coupes and the effect of cleanings and thinnings on its growth were analysed, but unfortunately it had proved impossible to adhere to the original project and the deviations from it defeated its primary aim of rendering statistical analysis possible.

In connection with the initiation of special research work on some factors connected with resin production in *Pinus longifolia* by the United Provinces, which work was inspected with the Provincial Silviculturist, material was collected for an examination of the distribution of resin ducts near the top of channels under tapping and a large number of counts made under the microscope. The data collected now await analysis.

A large amount of figuring and curve drawing was involved in the compilation and analysis of 6 years' data for the seasonal progress of height growth of several species of trees.

III.—MISCELLANEOUS.

(i) Photographic Section.

The routine work dealt with compares with previous years as follows :—

——	Negatives made.	Prints made.	Lantern slides made.
1931-32	1,071	2,661	60
1932-33	677	2,276	44
1933-34	1,095	2,271	400

It is satisfactory that the outturn of work has been more than maintained despite retrenchment in the Section.

Of the new negatives, 243 were photographs taken by the Silviculturist on tours in the United Provinces, South Bengal and South India, and 28 by the Experimental Assistant in the course of his bamboo field work, 232 concern the Timber Testing Section, and a further 592 were photographs taken for the other branches and sections of the Institute.

The negative collection of the United Provinces' Silviculturist has been lodged with the Institute, and Bihar and Orissa are likely to send in theirs also. The use of glass negatives has been largely discontinued in favour of cut films which, apart from technical points, possess special advantages in use, transport and storage.

The 2271 prints made were mainly enlargements from negatives of various sizes to the standard full plate size of the Institute photographic collections. The silvicultural collections have been increased by 310 to 3811 in the specific series and by 314 to 2976 in the general series. 235 prints were received directly or indirectly from provinces, a similar number to last year's. A selection of the more generally interesting additions were circulated to provinces as usual and copies supplied as required. 98 photographs were used as illustrations in various publications, and a number were used for an Industrial Exhibition at Delhi.

It will be noted that a large addition has been made to the lantern slide collection. The conversion of the print collections to a standard basis was only completed last year rendering it possible to take up the work of organising the lantern slide collection on similar improved lines. It is expected to complete this during the next year, after which maintenance and steady improvement of the collection should be a routine matter.

Considerably more stereoscopic photographs have been taken during the year and others are expected from provinces, but development in this direction is still needed.

The section has acquired a Cine-projector during the year, which should mark the beginning of expansion in a new field, though as yet we have no cinematographic camera.

(ii) Records.

Referencing work has more or less kept up with new foreign literature coming in during the year, but has been rendered more difficult by the lack of an assistant able to read German or French. The Silviculturist unaided cannot possibly find time to read or translate all articles in foreign languages which call for critical scrutiny, with the result that many have had to be referenced by title only.

Good progress has been made in marking for ledgering the very large accumulation of working plans, but the cutting up and filing has become a big task which will take some time. Indian forestry publications were abstracted for "Biological Abstracts" as usual.

The number of new specific files opened during the year was 7, bringing the total up to 1180, the corresponding figures for the general files being 10 and 431. The survey of available information on the regeneration

and management of *Shorea robusta* was completed and published, but it has not yet been possible to take up another species in the same way. The question of compiling a general manual of Indian Silviculture, which would be largely based on the general ledger files, is under consideration.

New volumes added to the Silvicultural library during the year totalled 40 (15 working plans), bringing the total to 633 books and 341 bound periodicals. The usual list of important additions was circulated with brief abstracts to Provincial Silviculturists.

(iii) Working Plans.

Notes have been written on West Almora, Tarai and Bhabar, Banda, Jorhat, Sadiya, Hamirpur, and S. Raipur (*sal*) draft working plans during the year, from four provinces, and the suggestions made have very generally been adopted. Calculation of yield continues to receive much attention, especially in the United Provinces where methods are being developed to ensure the maintenance of the outturn in timber sized trees, a matter which experience has shewn tended to receive insufficient attention under past methods relying on a general volume or area control only.

(iv) Museum.

A large scale model, 12′ × 6′, of forest management under the strip regeneration system was completed, and considerable progress made with one reproducing as nearly as possible to scale an actual deodar sample plot. The next to be constructed will be one to demonstrate the influence of forest cover on erosion.

(v) Staff and Touring.

The Silviculturist made a tour in the Kumaon circle of the United Provinces in May-June 1933 taking a sample plot field partly with which a thorough and satisfactory trial was made of measuring standing sample trees of *Pinus longifolia*. During this tour, a visit was also made with Provincial Silviculturist to the resin tapping experiments which mark an important advance in research methods as applied to such economic forest problems.

In November-December 1933, a six weeks' tour was made with the Conservator of Forests and the Bengal Silviculturist in the Chittagong forests where important progress has been made in the problem of the artificial regeneration of tropical evergreen species, and where experiments on natural regeneration and bamboo management are also being carried out. The experimental plots concerned were inspected and their further maintenance considered in light of results to date. A note was

prepared describing the chief points of this work and circulated to other interested provinces.

In January-March 1934, a prolonged tour was made in S. India, mostly with the Madras Silviculturist. and silvicultural work inspected in Madras, Coorg, Mysore. Travancore and Cochin. The progress made in experimental methods in Madras since the last visit in 1927 was most noticeable. The problems connected with the tropical evergreen forests were given special attention, and the opportunity utilised for studying the different types of forest occurring in South India and the interrelationships.

The Experimental Assistant made a prolonged tour to complete the series of experimental plots for the investigation of the best felling cycle and cutting methods for the bamboo *Dendrocalamus strictus*. The plots in the Punjab and United Provinces were revisited and a first felling made—these were later separately inspected and passed by the Silviculturist. Series of plots were also added in Orissa, the Central Provinces, and (after the end of the year) Madras.

The Statistical Assistant took out a sample plot field party which remeasured all the plots of Dehra Dun and Saharanpur divisions. This work would of course normally be done by the United Provinces' Silviculturist, but the arrangement was made to free his party for special work on the problem of the growth statistics of uneven aged forest in areas less easily accessible from Dehra Dun, a problem which is being specially taken up.

Mr. Mahendru reverted to the Punjab at the beginning of the year, and was succeeded as Statistical Assistant by Mr. Kakazai from the United Provinces; Mr Mahendru is now Silviculturist in his province. Mr. Deogun was Experimental Assistant throughout the year. There were no changes in the rest of the staff.

(vi) Forest grazing experiments.

Data collected in several divisions in the Central Provinces for the effect of various schemes of rotational closure with different grazing intensities and topographical features were examined at the request of the province and suggestions made for developing the project in the light of the results obtained and with modern research technique.

CHAPTER III.—BOTANY BRANCH.

1. *Systematic Botany.*—The systematic study of plants of the family *Dipterocarpaceæ* was carried out as follows. Two South Indian *Hopeas*, *H. wightiana* Wall. and *H. glabra* Wight and Arn., hitherto confused, and the Burmese trees *Scaphula glabra* Parker and *Anisoptera oblonga* Dyer, have been figured and described and the manuscript completed for submission for publication. Further studies and observations on Indian trees of this family for the continuation of this work were made by the writer during a visit to the Herbarium at the Royal Botanic Garden at Calcutta.

A paper dealing with a Burmese bamboo of forest importance, *Dendrochloa distans* Park., was published in the *Indian Forester* as well as a paper dealing with the Indian species of the genus *Xylocarpus*. trees of forest importance in Bengal and Burma. which have hitherto been confused both in botanical literature and in the field.

Dr. J. M. Cowan's paper on the genus *Wendlandia*, published in Notes of the Royal Botanic Gardens, Edinburgh, was summarised for the *Indian Forester* as this genus is of some forest importance and interest, and in this connection the herbarium material of the genus at the Dehra Dun herbarium was examined and re-arranged.

The collection and examination of a large amount of material of Indian *Terminalias* of the section *Pentaptera*, all trees of forest importance, has received the attention of the Forest Botanist and much of this material has been examined and sorted out and selected specimens sent to the Royal Botanic Gardens, Kew, and the Botanic Garden and Museum at Berlin for comparison with collections at the herbaria of those institutions.

2. *The Herbarium.*—3,271 sheets were added to the herbarium during the year from the collections of the Forest Botanist and his staff and of forest officers in India, and from specimens received by donation or exchange from other herbaria as shown below. The donation of nearly 2,800 Malayan sheets, the collections of Dr. Kunstler, Dr. King and the Rev. Fr. Scortechini, by the Superintendent of the Royal Botanic Garden, Calcutta, is much appreciated and forms a most valuable addition to this herbarium. These collections are now in the process of being incorporated.

Royal Botanic Garden, Calcutta	2,793
Forest Botanist, Maymyo, Burma	401
Herbarium of the Arnold Arboretum	328
Temple University, Philadelphia	200
Natural History Museum, Stockholm	87
Botanic Garden, Singapore	30
TOTAL	3,851

About one thousand specimens were distributed to other herbaria as donations or in exchange as follows :—

Botanic Garden and Museum, Berlin	333
Maymyo herbarium	244
Royal Botanic Gardens, Edinburgh	183
New York Botanic Garden	131
Botanic Garden, Sydney, N. S. W.	60
Temple University, Philadelphia	50
TOTAL	1,001

290 specimens were received on loan from the herbaria at Calcutta, Maymyo and Shillong, and 274 were sent out on loan chiefly to the Economic Botanist, Cawnpore (*Brassica* spp.), and to the herbaria at Calcutta, Berlin and the British Museum.

116 specimens were sent out for identification or the confirmation of identifications chiefly to Kew.

The re-arrangement of the foreign (non-Indian) collections in the herbarium was started during the year and the work has already progressed well. These collections have hitherto been placed in " Foreign " genus covers but the comparatively large increase in their number, obtained chiefly by exchange during the last few years, has made it necessary to re-arrange them under seven broad geographical units for convenience of reference. The Indian collections continue to be grouped under the three headings North-west and Central India, Bengal, Assam and Burma, and South India, and the non-Indian collections are now grouped as follows :—Asia east of India, Asia north of India, Asia west of India, Europe, America, Africa and Australasia.

3. *The Library.*—In addition to the usual number of periodicals added annually—about 60 in number—35 new books were added to the library during the year.

4. *Identification of specimens.*—About 900 specimens were identified during the year of which a large number are the collections of the Forest Botanist and his staff. The remainder were sent in chiefly by Dr. R. M. Gorrie (North-West Himalayan species) and Mr. H. G. Champion, Silviculturist (Chittagong and South Indian collections) and smaller lots by Forest Officers in India and Burma. In addition to the above the greater portion of a collection of 200 specimens brought in by the Forest Botanist from Bengal and of a collection of about 200 specimens from Lahaul and Spiti, sent in by Mr. H. A. C. Gill, I.C.S., have also been examined but have not yet been incorporated in the herbarium.

Tours.—A tour of about four weeks duration was made by the Forest Botanist in Northern Bengal with the Conservator of Forests of that

province in connection with the identification of trees in the Linear Sample Plots, chiefly in the Buxa and Jalpaiguri divisions. During this visit about 200 herbarium specimens were obtained. A short visit was also made to the forests of the Sunderbans for the collection of herbarium material of mangroves. In continuation of this tour the Forest Botanist spent about a week at the Herbarium of the Royal Botanic Garden, Calcutta, for the purpose of the examination of specimens of Dipterocarpaceæ and the critical comparison of material from the Dehra Dun herbarium with types at the Calcutta herbarium.

Kirat Ram, Field Assistant, accompanied the Inspector General of Forests on his visit to the Andaman Islands last February and remained there for the purpose of collecting specimens till about the end of March. His collections, amounting in all to 250 specimens in triplicate, have been received and await examination.

5. *Supply of Seed.*—In addition to numerous small authentic samples of seeds supplied to various scientific departments for experimental purposes and to various institutions on an exchange basis, twenty five larger indents, aggregating some 2,500 pounds of seed, were complied with during the year. The seed mostly in demand were *Pinus longifolia* and *Pinus khasya* for South Africa, *Cupressus torulosa* for South Africa and Ceylon, and *Dalbergia sissoo, D. cultrata, D. oliveri, Adina cordifolia* and *Pterocarpus marsupium* for Java.

In connection with the supply of seed the want of a collection of authentic samples for purposes of comparison is felt and a start has already been made in the building up of such a collection.

6. *Arboretum and Fruticetum.*—In the arboretum 41 trees representing 8 genera and 5 families and in the fruticetum 40 plants representing 11 genera and 9 families were planted out. In addition to these some 300 plants were raised in the botanical experimental garden for planting at New Forest and in the grounds of the Indian Military Academy.

Seeds obtained from the following plants were tested for germination and, proving fertile, these were added to our seed exchange list : *Acacia saligna* Wendl., *Aristolochia macroura* Gomez, *Enterolobium timbouva* Mart., *Millettia tetraptera* Kurz., *Rhynchosia minima*, DC., *Rivea hypocrateriformis* Choisy, *Sophora griffithii* Stocks.

The following plants flowered for the first time at New Forest : *Natsiatum herpeticum* Ham., *Chloranthus officinalis* Bl., *Naravelia zeylanica* DC., *Cassia multijuga* Rich., *Cymbopogon osmastonii* Parker, *Plantago lanceolata* Linn., *Gomphostemma parviflorum* Wall., *Cestrum diurnum* L., *Laportea gigas* Wedd., *Thunbergia natalensis* Hook, *Galtonia princeps* Dene., *Talinum paniculatum* Gærtn., *Solanum gilo* Raddi, *Solanum asymbrifolium* Lamk., *Halleria elliptica* L., *Petiveria alliacea* L., *Heteromorpha arborescens* Cham. & Schelecht.

Plantago lanceolata, one of the Psyllium-seed plants, flowered well during the last rainy season but owing, apparently, to late sowing and the excessive dampness at the time of flowering during the monsoon, would set no seed. At the time of writing, however, it is flowering again more profusely than ever and it appears likely that good seed will be obtained before the rains set in.

Paspalum dilatatum, a foodder grass from the Argentine, sown in 1932, is beginning to spread spontaneously in the experimental garden.

In the arboretum *Amoora wallichii*, *Afzelia quanzensis* and *Erythrina velutina* have been killed or badly damaged by frost, while more than one attempt to grow *Acacia koa* with success has failed, due apparently, to the want of proper bacterial root infection. On the other hand, several other introduced *Acacias* such as the South African green-barked *Acacia*, the Australian *A. confusa*, and the Indian species *A. suma*, *A. lenticularis* and *A. ferruginea* are doing well as also several other leguminous plants such as *Xylia dolabriformis* and *X. xylocarpa*, *Ceratonia siliqua* and *Derris robusta*.

A new botanical garden is being laid out in the grounds hitherto occupied by the Minor Forest Produce garden and the botanical experimental area, the former still being retained as part of the garden. A portion of this area has been allotted for experimental plots for the cultivation of plants of economic importance on a semi-commercial scale, while the remainder is being devoted to the planting of trees, shrubs and climbers of botanical interest or ornamental value.

7. *Miscellaneous.*—In the course of routine work advice and technical information was supplied to forest officers and other enquirers from various parts of India and Burma.

8. *Staff.*—The post of Forest Botanist was held throughout the year by Mr. C. E. Parkinson who was assisted by Mr. Mukat Behari Raizada, Lower Grade Assistant.

The Mycological work reported on below was carried out by Dr. K. D. Bagchee, Mycologist, Mr. A. Hafiz Khan, Upper Grade Assistant, and Mr. R. N. Chatterjee, Laboratory Assistant.

Mycology.

9. *Shisham root disease.*—The inoculations made on *shisham* (*Dalbergia sissoo*) trees with *Fusarium* sp. are showing successful results. Cultural studies of *Fusarium* sp. and of *Ganoderma lucidum* and *Polyporus gilvus* are being carried on.

The die-back disease of Gmelina arborea.—Cultural studies of the fungus isolated from dead leaves and twigs have been continued and the cultures have produced copious pycnial fruit-bodies which are comparable with those found on the infected leaves and twigs.

Inoculation experiments conducted on potted young plants in chambers, with controls, have successfully produced infection and show pycnial fruit bodies similar to those found on the naturally infected trees.

Peridermium himalayense.—Part 2 of the investigations on the infestation of this fungus on *Pinus longifolia* dealing with the distribution, morphology, pathology, biological relationship and control of the alternate stage *Cronartium himalayense* on *Swertia* has been published in the Indian Forest Records.

Peridermium indicum.—The morphological study of the fungus has been concluded.

Damping-off disease of seedlings of forest importance.—Some organisms known to cause damping-off have been isolated and are growing in culture and from observations made the percentage of damping off has been estimated for the following species:—*Soymida febrifuga, Terminalia tomentosa, Dalbergia latifolia, Dalbergia sissoo* and *Gmelina arborea.*

10. *Cultural studies of wood-rotting fungi.*—Cultural studies of six typical wood-rotting fungi common in the Indian forests and in timber yards have been undertaken. Inoculation experiments have been done on *Dalbergia sissoo* and *Dalbergia latifolia* grown under controlled conditions with two of these organisms to study their pathogenicity on living plants and also on blocks of wood of *Dalbergia sissoo* and *Adina cordifolia* to test, at the same time, the wood-rotting properties of these fungi. Two more will be taken up this year in this connection.

11. *Sal root disease including Polyporus shoreæ.*—A large number of specimens of diseased and dead sal trees from the United Provinces and Bihar and Orissa were examined. Some local tours were made in the Dehra Dun forest division to study the problem of sal mortality in the local forests and from observations it appears that the disease is correlated with drought conditions resulting from scanty rainfall during previous years. More evidence on this problem is being collected from the other divisions where sal has been dying during recent years and more material will be examined in this connection.

12. *Routine work.*—The collection and identification of hard fungi with the idea of building up our local collection for purposes of identification and reference is being continued; some notable additions have recently been made of *Polyporaceæ* and *Thallophoraceæ* from Bengal. Our Kumaon collections of *Polyporaceæ* have mostly been identified and incorporated. Arrangements are being made with specialists in Europe and America for the identification of Himalayan rusts and the exchange of these with European types.

Many enquiries and specimens for examination have been received from various forest divisions among which are included some interesting

tree fungi such as a rot on *Cinnamomum cecidodaphne* from Jalpaiguri, Bengal, and on teak from Angul, Bihar and Orissa, die-back specimens of *Michelia champaca* from Kurseong, Bengal, witches-broom specimens of bamboo from Lansdowne, United Provinces, specimens of dry rot in the timbers of *Phœbe hainesiana* and *Amoora wallichii* from Lumding, Assam, etc. These have been examined more or less in detail but are treated as problems secondary in importance to the sanctioned programme of work and are carried on as far as time permits.

CHAPTER IV.—ENTOMOLOGY BRANCH.

Insects of Sal.

As a result of the remedial measures carried out in Haldwani division, United Provinces, where the timber of sal trees, that were dying-off in thousands, was being depreciated by the attack of secondary borers, the trouble has been checked. The 3,700 commercially useless trees felled as traps absorbed most of the borer attack and the damage to standing dying trees was very much reduced. The control operations are being continued and an additional measure involving auctioning at the end of the monsoon and extraction before the following March is being adopted without loss of revenue to the department.

The cause of the mortality of sal, which still continues, was further investigated and it was found that the extensive carbonisation of the bark resembling scorching by fire is caused by an ascomycetous fungus, *Hypoxylon annulatum*, a saprophyte of dead bark and rotted wood. In the roots of dying and dead sal a mottled discolouration was produced by a fungus, *Polyporus gilvus*, which may be directly parasitic.

Insects of Teak.

Phassus malabaricus.—The Phassus borer of teak is extremely polyphagous; records were made of twenty-seven alternate food-plants most of which are shrubs or saplings of underwood trees forming the soil-cover in plantations. An attack by the borer in *Eucalyptus robusta* plantations in Coorg was found to have spread from the very high infestation of the dense undergrowth in this locality. The life-cycle is annual, moths emerging in May-June. A Dexiid has been obtained as parasite of the mature larva.

Defoliators.—The young foliage of *Kigelia pinnata* is an alternate food of *Hyblaea puera*; the older leaves are not eaten. Survival of *puera* caterpillars on teak is three times as great as on *Kigelia*.

An epidemic of *Hapalia machaeralis* occurred in the Central Provinces and at Dehra Dun towards the end of the monsoon of 1933. This appears to have been caused by the abnormally high rainfall of May-June 1933, bringing teak into leaf earlier and enabling æstivating moths of *machaeralis* to breed.

Diacrisia obliqua confusa was reared on teak, *Clerodendron infortunatum* and *Vitex negundo*. A pupal period of four months, December to April was recorded in Dehra Dun.

A study of the ecological factors influencing the incidence of defoliation in the Nilambur teak plantations, Madras, was made in April-May

1933. No correlation could be found between the initial appearance of defoliation on the new flush and the present state of the teak stand or the composition of its underwood, taking the compartment as a unit. The spread of the moths during the flight of the first generation from localities where winter survival is high counter-balances the deficient population in localities where survival is low. Over a period of years, however, the frequency of light defoliation is high in the age-class 1-10 years but the incidence of serious defoliation is not high; the frequency of general defoliation is highest in the age-classes 11 to 45 and the incidence of serious defoliation is also highest, being at its maximum in the 21-30 class; in the 51 to over 70 age-classes the frequency is lower than in the younger crops, and the incidence of serious defoliation is lower than at any age except under five years.

It is believed that the gradual falling off in the intensity of defoliation from the age of 30 years which becomes still more marked from the age of 50 years is due to the invasion and establishment of a mixed underwood with its accompanying micro-fauna, *i.e.*, to the gradual increase in the variety and efficiency of natural control in the form of predators and parasites. The relatively low intensity of serious defoliation in the first 10 years, on the other hand, appears to be an effect of the food-supply of the defoliators, as the young teak matures its foliage more rapidly at the critical season.

The biological control of teak defoliators is therefore a matter of the early introduction of an underwood or undergrowth, but one composed of species that favour the establishment of natural enemies. Ecological surveys are now in progress to determine the defoliator fauna of the common plant associates of teak in plantations from this aspect. As is usual a large proportion of the species of defoliators, predators and parasites resulting from such a survey prove to be new.

Insects of Sandal.

Analyses of collections.—The greater part of the insect fauna of the sample plots has been completely analysed and the seasonal incidence and distribution worked out for the Anthicidae, Cercopidae, Coccinellidae, Elateridae Formicidae, Fulgoridae, Jassidae, Membracidae, Neuroptera and Pentatomidae. In this work over 46,000 specimens were identified.

Taxonomy.—Reports on the identification of the insects of sandal, *Santalum album*, have been prepared by specialists and sent to press, *viz.*, Anthicidae by R. Heberdy; Melasidae and Elatridae by E. Fleutiaux: Jassidae by H. S. Pruthi; Coccinellidae by R. Korchefsky: Formicidae by D. Mukerji; Pentatomidae by N. C. Chatterjee; Thysanoptera by T. V. Ramakrishna Ayyar. These papers add 297 species and 167 genera to the insect fauna of sandal.

Bionomics.—Work on the life-histories of several sandal insects was continued and one paper was published in *Indian Forest Records.*

Transmission Experiments.—The work on the experimental transmission of the spike disease of sandal by means of insects was continued at the Insectary, Indian Institute of Science, until the end of September 1933. The results of two hundred experiments with thirty-one species of Hemiptera appear to confirm the theory previously advanced that if spike is carried by insects it is very probable that the Jassid, *Moonia albimaculata*, is a vector. Highly suspicious symptoms were obtained in five well-defined cases as the result of infection with viruliferous individuals of this species. A careful study of the symptoms and biological considerations, and analyses of total nitrogen and starch contents leads to the conclusion that these plants are spiked though not virulently so. A cytological examination by Mr. M. J. Narasimhan, Mycologist to the Mysore Department of Agriculture, supports this contention, intracellular inclusions having been found by him in sections prepared by him.

Lantana aphids are also suspected as vectors of spike disease, one plant apparently being infected as a result of transmission experiments. Seventy-two cases in which species of beetles were used yielded negative results.

These data have been published in the *Indian Forest Records* and have also formed the subject of some notes in *Nature*. The deduction that spike has been experimentally transmitted by insects and that *Moonia albimaculata* is a proved vector has not been generally accepted, mainly because leaves from the *Moonia* and aphid affected plants, when grafted on to healthy plants in order to ascertain if the diseased conditions were transmissible by grafting, failed to take and gave negative end-results. In the meantime the special grant subsidising research on spike disease has expired and the investigation has been closed down. It is a matter for regret that the retrospective decision of the Government of Madras to cease research on this subject makes it impossible to present unassailable scientific proofs of this achievement.

Insects of Bamboos.

Borers of felled bamboo, *Dinoderus* spp. In bamboos felled at the right season of year practically no damage takes place in the forest. The damage develops in the storage depots, where infested stock is held for more than a year. An article on the protective measures to be taken for stored bamboos was published in the *Indian Forester*. It was also demonstrated that the specifications for lance staves of solid bamboo, and for tent and telephone poles with regard to borer holes were unnecessarily strict, and that a revision of the specifications should reduce

considerably the price at which contractors can supply material, and should reduce the rejections of materials in use and reissued.

Damage by borers to living bamboos *Dendrocalamus strictus* was investigated in Landsdowne division, U. P., and at Dehra Dun ; the species concerned are *Estigmena chinensis* (Chrysomelidae), *Cyrtotrachelus* sp., and *Myocalandra exarata* (Curculionidae).

The beetles of *Estigmena chinensis* appear at the beginning of the monsoon and lay eggs under the sheaths on growing culms. The larvae feed superficially on the internode and finally bore into the thickness of the wall excavating a longitudinal narrow tunnel a few inches long in which pupation occurs in September. The beetles form in about a fortnight and remain in the tunnel from the autumn until the rains of the following year. Damage by this species appears to be most frequent in solid bamboos of small dimensions and in the solid part of large hollow bamboos ; thin walled hollow bamboos are not usually attacked. Second year and older culms are not attacked.

Damage believed to be due to *Cyrtotrachelus* is characterised by a long tunnel starting at a shallow excavation beneath a culm sheath and passing internally through several internodes, grooving the inner side of the wall, perforating each node passed, and terminating in a hollowed out and killed terminal shoot. The dead top of the culm may surmount a length of anything from a foot to fifteen feet of living culm if the bud is not killed right back at the beginning of the monsoon.

No living insects were found in the spring in culms attacked during the previous rains.

Damage of this type is commonest in dense crops of bamboos and in those unworked for more than four years. It is not entirely similar to the work of *C. longipes* in *Melocanna bambusoides* or in *D. strictus* in the Central Provinces.

Myocalandra exarata lays eggs in the abandoned tunnels of *E. chinensis* in second year and older culms. The tunnels run in the internodal wall and in solid internodes but do not penetrate nodes. The damage is entirely secondary to the attacks of primary borers.

A secondary disease of bamboos was found in which a fungus and a bacterium are associated.

Control measures appear to coincide with the prescriptions for the exploitation of bamboos already laid down in working plans. In cases of very bad attack by *E. chinensis* the cutting of the culms of the current year only is advised.

Insects of Champ.

An insectary was established in Kalimpong division, Bengal, in October to study the dying-back of *champ* (*Michelia champaca*) in planta-

tions and the insects associated with it. The pentatomid bug, *Urostylis punctigera*, was found to occur in all the *champ* plantations of Buxa, Darjeeling, Jalpaiguri, Kalimpong and Kurseong divisions and on natural forest trees. It also breeds on *Michelia excelsa* in the Tista valley and on *M. montana* at Lataguri. It is apparently an endemic species in the Duars and foothills of north Bengal.

The life-cycle of *U. punctigera* takes about 30 days in September and 45 to 105 days in the period October to January. The adults are long lived—up to 5½ months—and pass the colder weather sheltering in the dry or curled *champ* leaves on the tree. There is no indication of a prolonged period of hibernation or prolonged break in the reproductive activity of the insect. Egg-laying recommences about the middle of March.

It is improbable that the drain of sap from the young flush of foliage and stems by a massed attack of bugs is sufficient to cause the dying back of the whole crown or of the bole nearly to ground-level.

A rot due to a *Fusarium* producing *Nectria* fructifications in the later stages has been found and it is possible that this fungus is a primary disease of *champ*. The connection between the fungus and the bug is to be discovered.

Observations on the life-histories of defoliators, leaf-rollers and leaf-curlers and leaf-miners and shoot-borers of *champ* are in progress.

Insects of Deodar.

The investigation of the causes of the dying-off of deodar seedlings and transplants in nurseries was continued by visits to Chakrata division, U. P. In the spring very young seedlings are cut back by cutworms which appear to be half grown caterpillars that have hibernated. The cutworm population is mainly supported by weeds among which *Rumex nepalensis* is important.

Further observations on transplants showed that most of the casualties are due to causes other than insect attack, bad planting and desiccation being important factors. Cockchafer grub damage was slight.

Insects of Hollock, Mulberry, Oaks and Shisham.

The borers of felled hollock (*Terminalia myriocarpa*) are being investigated by breeding from logs exposed for various periods in Sadiya division, Assam, and Kalimpong division, Bengal, as a preliminary to the isolation of those species primarily attacking the living trees.

An *Indarbela* is reported as injurious to young saplings of this species in Sibsagar division, Assam.

Life-history studies of a defoliator of mulberry (*Morus indica*), a pyralid, *Glyphodes pyloalis* were continued at Dehra Dun.

Malacosoma indica occurred sporadically on *Quercus dilatata* and *Q. incana* in the Muktesar laboratory forests and in Naini Tal division in 1933 but no field-work was undertaken.

The life-history of *Apoderus sissu* (Curculionidae) a leaf roller of *shisham* (*Dalbergia sissoo*) has been commenced.

Borers of Indian Timbers.

The general survey of the borer fauna of forest trees and of the range of food-plants of the individual species of borers was continued. Material came chiefly from Assam and Bengal.

In Kalimpong division, Bengal, 13 species of trees were felled and exposed for a comparison of the effects of removing the bark from logs and leaving it intact. It was found that some species of trees are not liable to attack during the half year that includes the cold season, and that of other species liable to borer attack some are protected by leaving the bark intact, others by removing it immediately after felling. A similar project has been started with 30 species in Jalpaiguri division, Bengal.

Timber of *Bombax malabaricum* can be protected by removing the bark but when required for use in the manufacture of matches it is necessary to retain the bark. The value of treating the bark with creosote, crude petroleum and furnace oil was tested. None of these measures gave complete protection although each of the oils eliminated certain groups of borers.

Marine borers were studied at Beypore and Kallai, South Malabar, where the incidence of damage of *Teredo* and *Martesia fluminalis* varies with the location of the depot with reference to the salinity of the water. It was found that timber may be stored in tidal waters for a period of six months from the beginning of June to the end of December without any damage of commercial importance occurring. But that logs left in the water or newly immersed between January and May begin to be seriously affected by *Martesia* and less so by *Teredo*. In three months a penetration of about an inch depth may be expected.

Parasites and Predators.

Parasites of teak defoliators. The newly recorded species of parasites and hyperparasites include *Apanteles hyblaea, Cedria paradoxa, Chelonella* sp. (Braconidae); *Brachymeria euplocae,* (Chalcidae); *Echthromorpha notulatoria, Mesochorus plusiaephilus* (Ichneumonidae); *Actia hyalinata, Cadur-*

cia zetterstedti, Carcelia kockiana, Dolichocolon orbitale, Eutachina civiloides, Exorista heterusiae, Hapaliolaemus machaeralis, Nemorilla floralis, Ptychomyia remota, Sturmia inconspicuella, S. nigribarbis, S. parachrysops (Tachinidae).

The following species are parasites of both *machaeralis* and *puera; Elasmus brevicornis* (Elasmidae), *Ptychomyia remota* and *Sturmia inconspicuella* (Tachinidae).

Nine species of teak defoliator parasites are known from other hosts.

Predators of teak defoliators.—Several species of Mantidae which are fairly general feeders have been studied including *Creoboter urbana, Deiphobe* spp., *Ephestiaula intermediana, Hierodula westwoodi.* The life-cycles are either annual or two per annum, the adult mantis is long lived and the nymphs feed actively throughout the year except in regions where there is a cold season. Food is taken at the rate of one caterpillar per day or every second day.

An account of the biology of the Mantidae is in the press as an *Indian Forest Record.*

The life-histories of a Reduviid bug and of a spider are under observation. The Melyrid, *Idgia melanura,* is predacious in the larval stage on *machaeralis.*

Termites.

The investigation of the seasonal incidence of soil termites at Dehra Dun in relation to the factors of climate, food-supply and protection was concluded, and the results were applied to methods of comparing the efficiency of treated and untreated timbers in relation to termite attack. A technique was developed for the comparison of natural resistance, preservative efficiency and durability under experimental conditions, valuations of potential durability under conditions of use being impossible. The methods involve exposure of closely arranged test-pieces and baits in small plots, results being expressed in terms of useful life (durability), unattacked life and average density of termites per test-piece at the end of a fixed period (resistance). For preservative efficiency tests parallel experiments with material in covered trays are recommended. An account of the methods of testing the susceptibility of timbers to termite attack is in the press as a *Forest Record.*

A comprehensive article on control measures suitable for use against termites injurious to forest buildings, nurseries regeneration areas, and living trees was published in the *Indian Forester.* Judging by the sale of reprints of this article in various parts of the world it has served a useful purpose.

General Insectary Work.

During the year 194 consignments of attacked material and insect specimens were received from various forest divisions in India for identification, etc. In the Insectary 58 cages were discontinued and 552 cages were in progress. The total number of insects bred out was 57,964 and of these 15,676 were set and labelled.

Life-history studies were carried out on defoliators of *Acacia arabica*, *Albizzia procera*, *Cupressus* sp., *Eugenia jambolana*, *Kydia calycina*, *Mallotus philippinensis*, *Pinus longifolia*, *Santalum album*, *Shorea robusta*, *Terminalia tomentosa*.

The biology of gall making Psyllidae was almost completed.

Advice was given on the introduction and propagation of cochineal insects for the destruction of prickly pear and an article was published in the *Indian Forester* on the subject.

Systematic Entomology.

The insect collection now contains 13,587 different species of insects, 287 species having been added during the year. The collection of immature stages has been greatly increased and particular attention has been given by the Systematic Entomologist to the classification of coleopterous larvae; two *Records* on the subject are in press. It is of interest to note that insect specimens sent with enquiries by forest officers are most frequently in the larval stage; although a great proportion of coleopterous larvae can now be accurately identified, most lepidopterous larvae are unknown and a collection of these is being built up with a view to study and classification.

As in former years numerous specialists have assisted in the classification of our collection of adults, and have described Indian species in many scientific publications. Especial acknowledgments are due to the specialists in the British Museum, to the Imperial Bureau of Entomology under Sir Guy Marshall and to Dr. T. E. Snyder of the United States Bureau of Entomology. The latter has studied and classified a very large collection of Termitidae, which had remained untouched for many years as no other specialist would undertake the work.

A paper on certain African beetle larvae of economic importance, prepared at the request of the Government Entomologist, Uganda, has been published in London.

The Forest Entomologist continued the study of Oriental Scolytidae and Platypodidae (43) including the identification of the material in these families collected by the Pacific Entomological Survey. Several reports were completed in the series Entomological Investigations on the Spike

Disease of Sandal (44) bringing the number sent to press up to twenty-four.

Tours.—By Dr. Beeson to timber mills and depots in Bombay, Madras, and Calicut; to Nilambur, Madras and to Coorg in April; to Bangalore (Spike Conference) in April; to Kalimpong, Bengal in October; to Ranchi (Lac Cess Committee) in October and March; to Lansdowne, United Provinces in February. By Mr. Gardner to Chakrata, United Provinces, in April. By Mr. N. C. Chatterjee to Nilambur in April-May; to Kalimpong, Kurseong and Jalpaiguri, Bengal in September November and March; by Mr. Dover to North Salem, Madras in May; by Mr. Bhatia to Chakrata, United Provinces in April and June; to Lansdowne in February. By Mr. S. N. Chatterjee to Nilambur and Coorg in April.

Museums.—The entomological museum continues its steady growth, the principal accessions were 206 specimens of damage to timbers by borers. Specimens of reptiles and amphibia were added to the zoological museum. A set of exhibits was prepared for display at agricultural or industrial exhibitions in the provinces.

Library.—192 books besides periodicals were added to the Zoological Library during the year.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. *Research.*

(*a*) Work in connection with the preparation of a hand lens key for the identification of the important commercial timbers of the Punjab was completed and is now in the press. In this bulletin, a full macroscopic description of various timbers, as well as short notes on their strength, seasoning properties, durability, working qualities, and supply and uses have been given. As these notes are the latest available for the timbers in question, it is hoped that the bulletin will prove useful to all interested in the timber-trade.

(*b*) Studies in the formation of growth rings in the woods of *Acacia catechu*, *Bombax malabaricum*, *Eugenia jambolana*, *Pinus longifolia*. *Shorea robusta*, *Tectona grandis* and *Terminalia tomentosa* were continued during the year. While making a critical examination of the wood blocks of *Terminalia tomentosa*, a hitherto undescribed type of parenchyma distribution was discovered. It was found that the so-called terminal parenchyma cells of *Terminalia tomentosa* are not really terminal but initial. Since this type of parenchyma distribution is apparently something new, a short note on the subject was published in *Nature*, Vol. 133, p. 215, February 10, 1934, to bring the matter to the attention of plant anatomists and wood technologists in different parts of the world. During the coming year, the remaining species will be critically studied.

(*c*) Research on the anatomical study of the wood of Indian Dipterocarps was continued during the year. 164 specimens were cut, of which 94 specimens were studied and their anatomical data taken down.

More specimens will be cut and studied, during the coming year.

(*d*) Experiments in connection with the improved method of softening micro-blocks in hydrofluoric acid were completed with success. Tropical timbers generally, being hard, require softening with hydrofluoric acid before any thin section can be cut. Most of the hard Indian timbers used to take about 6-8 weeks to soften, which is a long time, especially if the identification required is urgent. During the last 2 years experiments have been carried out on various timbers with a view to shortening the time required for softening. Ultimately this difficulty was overcome by using a pressure cylinder similar to that used by Lodewick for his "shorter celloidin method," but some modifications were necessary to suit the present work. The results obtained have been very satisfactory. Timbers which used to take 6 weeks to soften can now be

softened under pressure in a week's time, and those taking 8 weeks in 10-15 days. Details of the new method have been published in the *Annals of Botany* for January 1934.

(*e*) The study of the different varieties of *Terminalia tomentosa* (laurel) was continued during the year. All laurel trees do not have the good figured wood which usually fetches a very high price in the foreign market, in fact this figured wood is rather rare. The idea underlying this research was to find out whether good figured wood is confined to certain varieties of laurel or not and to discover whether such varieties can be differentinted botanically, so that seed from such trees could be used for regeneration purposes. Burma, Madras and Bombay are interested in this problem.

(*f*) To study the relationship between the anatomical structure and physical properties in common commercial timbers of India, work has been started with *Tectona grandis* (teak) from Burma. Ninety-one specimens have been received representing wide ringed heavy teak, normal teak and wide ringed light teak. These specimens are also being tested in the Timber Testing Section to find out their strength values.

(*g*) A study of the woods of the Indian *Meliaceae* (Mahogany family) has been started. Wood blocks are being prepared for cutting sections.

2. *Identification of Woods.*

As usual, a large number of timbers were received from various sources for identification. Among these there were one or two of historical interest. The Inspector General of Forests while on tour in Andaman Islands obtained a small piece of wood from a British sailing ship which was said to have been wrecked 70 years ago and had finally drifted into a mangrove swamp. The wood was very much discoloured and distorted and on examination was identified as European birch. On another occasion a small piece of wood from the gate of the Purana Killa at Delhi was sent for identification. It was found to be a perfectly sound piece of sal (*Shorea robusta*). In this connection it is interesting to note the following :—"Purana Killa was built or restored by the Emperor Humayun in 1530 and was abandoned shortly after his death in 1556. After this date no one would have been likely to repair the gate ; so that this sal gate has fulfilled its purpose for more than 400 years."

The total number of timbers identified during the year was about 300.

3. *Examination for Fungus.*

Various enquirers sent samples of wood suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 55.

4. *Special Enquiries.*

Several special problems were taken up on behalf of research officers of the Institute and forest officers in the provinces. Work was also done for several business firms. In this connection 123 wood specimens were examined.

5. *Accumulation of Anatomical Data.*

In the course of routine work, over 80 data sheets were filled up and filed for future reference.

6. *Collection of Authentic Wood Specimens.*

(*a*) In India :—Several authentic wood specimens were received for the standard collection.

(*b*) From abroad :—During the year altogether 190 wood specimens were received from the Fan Memorial Institute of Biology, China; the Director, Forest Products Laboratory, Princes Risborough, England; East Africa, South Africa and the Federated Malay States. To the donors our sincere thanks are due for helping the Forest Research Institute to make a complete collection of the commercial timbers of the world.

7. *Distribution of wood specimens.*

In response to requests from abroad and from various parts of India, 776 samples of timber were sent out to interested inquirers.

8. *General.*

Short courses in Wood Technology were given to the following officers :—

(*a*) Mr. H. M. R. Morse, Works Manager, North-Western Railway.

(*b*) Mr. C. R. Grey, Assistant Works Manager, North-Western Railway.

(*c*) Mr. D. Mukerjee, Professor, Ceylon Technical College, Colombo.

(*d*) Mr. R. M. Mubayi, Student Sleeper Passing Officer, Eastern Group, Calcutta.

Over 70 photomicrographs were sent to various persons interested in wood identification.

9. *Publications.*

See Appendix I.

Timber Testing Section.

1. *Staff.*

The work of the Timber Testing Section has of necessity been slowed down considerably by the reduction of staff consequent upon the retrenchment which accompanied the financial depression. In spite of this a considerable amount of work has been done and a reasonable balance maintained between tests and computation work.

2. *Special Investigations.*

(*a*) The study of the influence of friction on the results obtained with the standard shearing test tool was continued. A large number of matched specimens were tested in the standard tool and in a specially constructed tool with roller bearings. It was found that the influence of friction on the observed results was negligible, far greater variations being introduced by the shape of the test specimen and by the manner in which it was held in the tool. Sufficient data have been obtained and studied to indicate that the standard method of testing shearing strength in wood yields very useful results which are suitable as a basis of comparison between species.

(*b*) The study of the effect of wood coatings in retarding the passage of moisture was discontinued on account of shortage of staff and the necessity of employing them on other work. The results obtained were inconclusive but indicate that most wood coatings, as commonly used, do not develop their full waterproofing capacity because insufficient material is applied and the coatings are not truly continuous. There was also evidence that lacquer, cellulose and varnish coatings, if applied in sufficient quantity and formed into a continuous coat, very greatly retard the passage of moisture.

(*c*) Tests were continued on glue joints supplied by Ground Engineers through the Inspector of Civil Aviation. It is gratifying to note that it has now become a comparatively rare occurrence for a Ground Engineer's work to fail to come up to specification.

(*d*) Tests were made to investigate the physical condition of a teak sole bar taken from a railway wagon which had been damaged in derailment. It was found that, though the bar had in the first place been made of poor quality teak, the strength was sufficient for the purpose for which it had been used. There was strong evidence that the breakage of the sole bar had been the result of abnormal stresses caused by the derailment.

(*e*) A few tests were made of timber connectors such as are used in modern construction abroad. It was found that these connectors very materially improve timber joints. It was especially noted that babul

(*Acacia arabica*) coned dowels of the Kubler type, if properly designed and applied, are easy to fit and produce excellent joints. These connectors not only increase the strength of the joint but, a matter which is often of greater importance, very considerably reduce the distortion of joints under moderate loading.

(*f*) A series of tests was made to compare the mechanical properties of very wide ringed (fast grown) teak with those of normal teak. While the final conclusions must await the report of the Wood Technology Section on the structure of the wood, the mechanical tests indicate that, though rapid growth in ring porous woods is usually accompanied by the production of strong tissues, there is an optimum beyond which increased rate of growth in teak may be accompanied by reduction in strength. It also appears that in teak of extremely rapid growth the weight of the wood may depend more on the presence of infiltration products than is normally the case. No seriously defective material, however, was encountered except when the growth rate was excessively rapid, and material having 4 rings per inch or more was found to be of good quality. This must not be taken to mean that extremely slow growth on the other hand is good. Very slowly grown teak is usually of inferior quality also.

(*g*) A few tests were made to compare the strength of solid wood with that of plywood. When used as panels the 3-ply wood resisted practically three times the load carried by an equal thickness of solid wood. Tested in the same way 5-ply panels carried more than four times the load which could be carried by solid panels of the same thickness.

(*h*) Plywood boxes of hollong (*Dipterocarpus macrocarpus*, Vesq.) prepared by a firm in India were submitted to strength tests. The results obtained with these boxes were at least equal to, (in some cases better than), results obtained with imported plywood boxes.

(*i*) A new type of collapsible packing box designed and built at the Forest Research Institute was tested and gave promising results. This work is still engaging the attention of the Wood Workshop Section.

(*j*) The Officer in Charge was placed on special duty to conduct a study which should lead to the preparation of grading rules for Burma teak. A visit was paid to Calcutta and Rangoon and the position discussed with railway officers and teak dealers. A report was written on the information obtained, and arrangements were made to collect data over a period of some months in order to have reliable facts and figures on which subsequently to base grading rules.

3. *Routine Testing.*

In spite of the small staff now employed, work was vigorously prosecuted under Project No. 1 (Standard Tests of Small Clear Specimens)

and Project No. 2 (Standard Tests of Structural Timbers). Routine testing was also done on glues, ply woods, containers, etc., in co-operation with the Wood Workshop Section.

No. of species tested during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	7	2	4	
Project 2	3	3	..	
Project 0 under various sub-heads	..	..	..	36 consignments.
Tests of glue joints for aircraft	..	..	..	33 consignments.

No. of species computed during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	7	2	5	
Project 2	3	3	..	
Project 0 under various sub-heads	..	..	..	42 consignments.
Tests of glue joints for aircraft	..	..	..	33 consignments.

Over 12,000 mechanical tests and nearly 13,500 physical determinations were made during the year. Besides routine computations numerous tables and graphs were prepared for publication and for answering enquiries. The work started last year in the preparation of graphs for the determination of the annual cost of sleepers was completed. In connection with the special shrinkage study 9,000 observations were recorded during the year: these results indicate that under climatic conditions in Dehra Dun the shrinkage from the green to the air-dry condition is approximately half the total shrinkage from the green to the oven dry condition, and that the method of treatment, except at the very start of seasoning, has no appreciable effect on the result.

4. *Publications.*

See Appendix I.

5. *Technical Notes and Advice.*

The number of technical notes and letters of technical advice was somewhat reduced during the year on account of the Officer in Charge being absent on leave during part of the year. In spite of this, 99 technical letters and notes were issued on various subjects among which the following may be mentioned :—

1. Wood for cross arms on transmission lines.

2. Effect of preservative treatment on *Terminalia tomentosa* (not deleterious).
3. Wood for pick-axe helves.
4. The relative strength of heartwood and sapwood.
5. Wood for aeroplane spars.
6. Wood for cart wheels.
7. Wood for machine bearings.
8. Wood for spring boards.
9. Indigenous substitutes for hickory.
10. Indigenous substitutes for ash in bent work.
11. Working stresses and specifications for transmission line poles.
12. Timber for boat building to be used in salt water.
13. Information concerning flooring timbers.
14. Bobbins.
15. Sports goods.
16. The use of sissoo in railway carriages.
17. Framing of grading rules for structural timber and for lumber.
18. Timber for decking.
19. Shoe lasts.
20. The strength of wooden sole bars in railway wagons.
21. Timber for shuttles, tool handles, camera stands, folding chairs and sports goods.
22. Barrel making.
23. Modren connectors for timber structures.

Realization of the value of strength data and general information as to the suitability of various indigenous species for particular uses is gradually increasing, and there is consequently a growing appreciation of the importance of the scientific study of Indian woods for which the Forest Research Institute is responsible.

Wood Seasoning Section.

1. *New Method of Kiln Drying.*

During the year considerable progress was made with the new method of kiln drying described in detail in last year's report. A number of kiln charges of various species were dried, and in most cases satisfactory results were obtained. With laurel (*Terminalia tomentosa*), sissoo (*Dalbergia sissoo*) and toon (*Cedrela toona*). it has been possible to shorten the time of drying, reduce the consumption of steam and of electric

current, and obtain kiln-dried material practically free from any permanent set without any intermediate steaming operations.

It is interesting to note that a charge of one inch thick laurel (*Terminalia tomentosa*) planks was dried from the green condition to 10 per cent. moisture content in 12 days. This is perhaps the shortest time in which this timber has ever been kiln dried. The condition of the timber at the end of process was extremely satisfactory, there being no appreciable increase in degrade. The final tests showed the absence of any case-hardening stresses, as well as a uniform distribution of the moisture in the wood. The total consumption of steam was 13,256 lb. for drying a charge of about 165 c.ft. of laurel, containing about 32 lb. of water per cubic foot. The consumption of steam per pound of moisture evaporated from the wood comes to about 3 lb., which is a much lower figure than that of any previous results.

A further advance has been made in that it was found that during the cooling period it is not necessary to work the fans continuously. As a matter of fact, if the circulation is stopped, there is a tendency for the humidity to rise in the stack, which helps in raising the moisture content of the surface layers, and thus brings about a better outward diffusion of moisture, and at the same time more effectively neutralizes any stresses developed during the heating period. It has been found that a short period of fan circulation, say for 2 to 3 minutes every half hour during the cooling stage, is quite sufficient. In order to equalize the humidity conditions within the stack, it is useful to instal some dampers in the baffle walls of the fan system, which can be opened during the cooling period, thus taking full advantage of the thermal circulation within the stack. It may be stated that for a small sized kiln having a capacity of about 200 c.ft. of wood, and working with a 2 H. P. electric motor, the current consumption has been reduced from about 20 units per day to only about 2 to 3 units per day by using this new method.

Everything has not, however, gone quite smoothly with this new method of kiln drying. It has been found that the kiln walls, on account of their porous nature, upset the drying conditions inside the kilns. If drying is done in a kiln of non-porous construction, say of iron-sheeting, the relative humidity tends to reach the saturation point at the end of the cooling period. With brick kilns this is not so. The relative humidity of the air at the end of the cooling period in the kiln is always lower than it really should be, with the result that there is a tendency for the surface layers to dry, and thus set up a moisture gradient in the wood. This effect is more pronounced in small kilns, where the quantity of wood is very small compared with the wall area.

Similar difficulty has been found in constant humidity chambers built of brick-work and concrete. With pure water in trays over which

the air continuously circulates, it has not been possible to attain a humidity higher than 92 per cent. With saturated salt solutions, the relative humidity obtained is always lower than the values given in the International Critical Tables.

Work is now in progress to determine conditions of drying which would be applicable to ordinary kilns of brick and mortar construction. Further studies are being made of the movement of heat and of moisture during the various stages of heating and cooling, because a knowledge of these phenomena is very necessary in order to be able to specify the maximum temperature and the length of heating period necessary for any particular timber.

At the Institute at Dehra Dun, there are two miniature and two large sized kilns equipped with internal fans for air circulation and during the period the boilers were working (about 7 months in the year, owing to reduction in budget grants), all four kilns were kept busy. In all, 25 charges of timber were kiln-dried, and useful data have been obtained on the drying of various species.

2. *Kiln Drying with Ozone.*

It has now been definitely established that there is no benefit whatsoever in adding ozone to the circulating air in a kiln. Experiments were carried out with matched specimens of the following four species of wood, which were dried with and without the addition of ozone at a relatively low temperature (35°C), so as to avoid any decomposition of ozone which might take place at high temperatures :—

1. *Anogeissus latifolia.*
2. *Hardwickia pinata.*
3. *Palaquium ellipticum.*
4. *Schima wallichii.*

It was found that the addition of ozone did not have any effect on the rate of drying or on the shrinkage of any of the species under test. The claim is made by interested parties that timber dried with ozone is more stable, *i.e.*, less prone to subsequent swelling and shrinkage when exposed to various atmospheric humidities. This claim has been definitely disproved, and it has been clearly brought out by experiments that not only is the subsequent swelling and shrinkage the same in pieces dried with or without ozone, but the rate of change with time *i.e.*, the hygroscopicity is also not affected. A detailed report on the experiments is under preparation.

3. *Drying under Vacuum.*

No detailed work was carried out with vacuum drying, except one small test to verify the claim made by a Swedish firm. It was held by

them that the application of a sudden vacuum to green wood brings out the liquid moisture held in the capillary spaces of the wood. They suggested a plant consisting of two cylinders of equal size, one of which is under vacuum, and which is then connected to the other at atmospheric pressure, which would mean a sudden application of vacuum of not more than 15 inches. This idea was tried with the only difference that 2 cylinders of unequal size were connected. The large cylinder, about 200 times the size of the small one, was exhausted till it showed a vacuum of 26 inches. The small cylinder contained pieces of wood fully saturated with water, and when the two were connected, it was found that there was hardly any change in the vacuum gauge on the big cylinder, while that on the small cylinder showed a vacuum of 26 inches. Even under these conditions, not even the smallest amount of moisture was found to have come out of the fully saturated pieces of wood of any of thespecies tested. It is not uncommon that, for the sake of advertising, various firms all over the world put up such quasi-scientific and plausible looking claims, for which there is no experimental justification whatsoever, and it is only by testing such claims that the truth can be discovered. Many such claims have been tested at the Forest Research Institute and any one interested in such new and plausible ideas would do well to consult the Institute before they embark on any new venture.

4. *Air-Seasoning.*

Small air-seasoning experiments were started on about a dozen species, and observations were continued on all the species stacked last year for air-seasoning.

The most important piece of work done, however, was the writing up of a "Manual on the air-seasoning of Indian Timbers" which includes detailed seasoning characteristics of 120 of the more important indigenous woods. The Manual will be published during the coming year.

5. *Seasoning of Softwood Railway Sleepers.*

Another air-seasoning experiment on softwood railway sleepers in co-operation with the Punjab Forest Department and the North Western Railway was started during the year at Dhilwan in the Punjab, with the object of finding out the most suitable method of stacking, the time required for proper air-seasoning, and the effect of end-coating of sleepers. Three species, namely deodar (*Cedrus deodara*), chir (*Pinus longifolia*) and fir (*Abies pindrow*) were included in the experiment and the stacking was done in December 1933. At the end of March, all the sleepers were inspected carefully for any degrade during the period of seasoning, and a large number of moisture content tests were taken. The experiment is still in progress, but the results obtained so far are very conclusive and

interesting, and based on them the following recommendations can be made :—

(*a*) All softwood sleepers should be end-coated with thick tar or some other suitable material as soon as possible after the sleepers are taken out of water.

(*b*) Deodar, and very likely fir, can be stacked in close crib manner after end-painting, provided the stacks are protected against too rapid drying from the ends and the top. Chir sleepers should be stacked in the 1 and 9 method on account of their liability to fungus attack.

(*c*) Seasoning should be continued till the sleepers are fully dry. The exact time will be known at the end of the experiment, but it is, in any case, much longer than 3 months.

6. *Laboratory Experiments.*

(i) Methods of moisture determination. The work on this item was completed during the year, and a paper has been written up for publication. The important conclusions are :—

(*a*) For all practical purposes, the oven drying method of determining moisture-content by drying test-sections about $\frac{1}{2}$-inch thick along the grain in an oven at about 100°C gives reliable results, except in the case of timbers containing large amounts of volatile constituents, such as deodar.

(*b*) In the case of woods containing a large percentage of volatile constituents, the distillation method should be adopted, using water-saturated xylol, and reflux distillation if possible.

(*c*) Volatile constituents in deodar may vary from $1\frac{1}{2}$ to 10 per cent., the average value being about $5\frac{1}{2}$ per cent.

(*d*) Chir, gurjun (*Dipterocarpus* spp.) and *pali* (*Dichopsis elliptica*) contain about 1 per cent. of volatile matter.

(*e*) Thingan (*Hopea odorata*) and teak contain only negligible quantities of volatile substances, if any.

(ii) Shrinkage and hygroscopicity experiments : Work on the five species taken up last year was continued, and two more species were taken in hand. It has been found that shrinkage and hygroscopicity are not at all appreciably affected by any of the various treatments, such as steaming, soaking in water, boiling, kiln-drying, etc. Experiments have been started on the impregnation of wood with various substances, such as sugar, glycerine, sodium silicate, etc. It will be interesting to know definitely what effect, if any, these exert on the shrinkage and swelling of wood.

(iii) Moisture movement with heat: Working with small cylinders of wood, it has been definitely established that moisture moves in the direction of the heat flow in wood. This is an important discovery and work is in progress to determine a relation between the two. The fundamentals of the new process of kiln-drying, described under item 1, are based on the establishment of a temperature gradient from the inside to the surface during the cooling stage, which would tend to bring the moisture out from the centre.

7. *Enquiries.*

During the year 28 enquiries were replied to on various subjects relating to the air and kiln-seasoning of timber. Detailed instructions for the operation of seasoning kilns were supplied to two firms in Assam and Bengal respectively, and specifications for a timber drying-kiln were sent to a timber merchant at Rawalpindi.

8. *Training.*

An officer from the Gramophone Co. Ltd., Calcutta, was trained in the operation of seasoning kilns. Mr. Mubayi, Assistant Sleeper Passing Officer, Eastern Group, was given training in the seasoning of railway sleepers. Mr. D. Mukerji, an officer of Ceylon Government, also spent a week in the Section, picking up general information relating to the seasoning of timbers.

9. *Publications.*

"A Manual on the air-seasoning of Indian Timbers" by Dr. S. N. Kapur, Officer in Charge, Seasoning Section, has been prepared and submitted for publication.

A paper on the "Study of some common methods of determining moisture n wood, with particular reference to woods containing volatile constituents" by S. N. Kapur and D. Narayanamurti has been written up and will be published shortly.

10. *Tours.*

In connection with the air-seasoning experiment on softwood railway sleepers in the Punjab, a number of visits were paid to Dhilwan by Dr. S. N. Kapur, and Mr. Azizul Rahman, Upper Grade Assistant, Seasoning Section.

Wood Preservation Section.

Mr. S. Kamesam was in charge of the Section throughout the year except for a period of about 3 months when he was absent on leave.

1. *The ASCU Wood Preservation Process.*

The most important achievement of the section during the year under review was the perfection of a wood preservative consisting of arsenic (*As*) and copper (*Cu*) compounds which can be employed in aqueous solution for injection into wood in steel pressure cylinders. It has been called " ASCU," and is a logical development of the Falkamesam process. Patents for the process have been granted to the inventor, Mr. S. Kamesam (Officer in Charge of the Section) in Great Britain and India ; patents are pending in the United States of America, Canada, Mexico, Argentine, Brazil, South Africa, and Australia, but the Indian Government have reserved for themselves the right to use the process, as and when required, free of charge. It is the first wood preservative containing arsenic and copper (compounded in the most effective proportions) which appears to ensure a high optimum degree of fixation, individually, of arsenic and copper in wood. In addition, despite the presence of copper, it is said to be entirely non-corrosive to steel, iron, and brass, and to be perfectly stable in contact with these metals. The previous use of arsenic and copper as wood preservatives has been extensive and well-known. Even at present, copper sulphate is employed for treating annually a few lakhs of wooden telegraph and telephone poles in France. Recent experiments conducted by this Section indicate that, for a unit of money, arsenic affords the maximum toxicity against wood destroying fungi, and a high degree of protection against termites, while copper is even superior to arsenic as far as termites are concerned.

During the year, experiments based on a new and accelerated technique for testing the relative efficacy of wood preservatives, indicated that a 4 per cent. solution of arsenic and copper in the proportion of 1 to 3 corresponds (on the basis of wood preserving efficacy) to undiluted 100 per cent coal tar creosote, so that, as regards relative cost, if a gallon of creosote costs on the average about a rupee, ASCU costs only about $2\frac{1}{2}$ to 3 annas. In Dehra Dun creosote is not available for less than about Rs. 2 per gallon.

2. *The Railway Board Special Committee.*

During May, 1933, an *ad hoc* committee was appointed by the Railway Board, with Sir C. V. Raman, F.R.S., N.L., in the chair. The other members were Messrs. J. M. D. Wrench and A. F. Harvey, Directors of Engineering, Railway Board, Mr. R. H. Irani, Senior Government Inspector of Railways, Bombay, and Mr. R Sephton, Chief Engineer, Great Indian Peninsula Railway. The Committee sat for three days at Dehra Dun investigating the claims of the Falkamesam process which Mr. Kamesam has now improved upon with the *ASCU* process which ensures not only the fixation of arsenic (as in Falkamesam) but of copper

also. Although the committee has not yet submitted their report, the chairman, on the basis of experiments made under his supervision at the Indian Institute of Science, Bangalore, has written to the Forest Research Institute that the inventor's claims regarding the fixation of arsenic in wood were "entirely substantiated."

The Director General, Posts and Telegraphs, Government of India, deputed Mr. M. N. Crawford, Director of Telegraph Engineering, United Provinces Circle, to attend the deliberations of the committee, and to report on the advisability of using treated wood in place of galvanised iron tubular poles, and also to report,—if treated wood poles are more economical,—as to the kind of chemical treatment that should be given to the poles for protection against decay and termite attack. It is understood that Mr. Crawford reported that he was not only convinced that properly treated wood poles would be more economical than iron poles, but that the ASCU process would be the best process to adopt for the Posts and Telegraphs Department.

3. *Emulsion of Falkamesam and Crude Oil.*

Several prominent railway engineers are of opinion that, if the Falkamesam or the ASCU process is to be adopted for treating railway sleepers in India, a supplementary anti-splitting impregnation of crude oil into wood would be necessary. For combining crude oil injection with the antiseptic impregnation in one movement, several experiments were made to determine whether a suitable emulsion of the oil and the solution could be made. Such an emulsion should be fine and stable enough to penetrate at least the sapwood of chir pine without the oil or the water separating unduly during the process. Viscosity observations made on emulsions containing different proportions of crude oil and the antiseptic solution were made; the effect of the degree of emulsification on the viscosity of the resulting emulsion was also studied. Although fine emulsions with the fluids could be obtained, it was noticed that the preservative got decomposed after standing for a short time, as part of the chemicals was precipitated. A single movement process involving the injection of Falkamesam and crude oil did not therefore appear to be practicable, and if an oil treatment is considered necessary, in addition to an ASCU or Falkamesam treatment, it will be necessary to do this separately. A dipping treatment in crude oil will probably be quite sufficient.

4. *A New Method of Accelerated Service Test with Wood Preservatives.*

During the year, a new method of testing wood preservatives in the antiseptic "grave-yard" was introduced. This bids fair to yield reliable results of considerable value in a very short time. Instead of employing sticks (even as small as an inch square in cross-section) impregnated

with the preservative under test, fresh rotary-cut veneers of a very perishable wood like semul (*Bombax malabaricum*) are used. The veneers are only a sixteenth of an inch thick, an inch wide and six inches long. They are treated in an open tank, ensuring a complete penetration of the preservative fluid. Before the rainy season starts, they are placed in the Institute test-yard with half their length buried in the ground.

The superiority of the above method is based on the following considerations:—

(*a*) When a wood post placed in the ground is eventually destroyed by white ants or rot, the attack proceeds from one outer peripheral lamina to the next contiguous one inside. In veneer specimens, if the attack is confined to but a depth of 1/48 inch (a very small thickness) on either side, the middle 1/48 inch section has hardly any mechanical strength, so that it easily crumbles to pieces. Hence if the veneers are sound for a year, the concentration of chemical that has protected the veneer for that period may with reasonable safety be adopted in actual practice.

(*b*) As the test veneers should be preferably rotary-cut their surface is tangential and is, therefore, very similar to that of a round pole under service conditions.

(*c*) As the veneers are of a wood with large open pores, and are laid in the ground during the rainy season (at Dehra Dun the precipitation amounts to about 80 to 90 inches in about three months), and since the pieces are very thin and are exposed to the sun, the leaching and volatilisation conditions to which they are exposed can be taken as very severe. It may be noted also that the thin veneers are exposed on both their broad faces to leaching and volatilisation, whereas in a wood pole, the thin outer lamina is exposed to such conditions only over one face.

(*d*) As the buried pieces have practically only two dimensions, the precise extent of damage at the time of different inspections can be evaluated and recorded accurately, reducing the personal factor in such inspections to a minimum.

(*e*) The untreated controls are destroyed in a very short time in most cases, so that if the treated veneers in the same localities last for 9 months to a year, the treatment must have considerable merit.

5. *Veneers Tests Applied to Five Wood Preservatives.*

Creosote and four efficient inorganic wood preserving chemicals were employed in graded concentrations for test with semul veneers. The

four inorganic chemicals were deliberately chosen from those that offer a fair or a high degree of resistance to being washed out, or to evaporating from the wood into which they are injected. They consisted of (1) "fixed" copper (2) "fixed" arsenic (Falkamesam), (3) "fixed" arsenic and copper (ASCU), (4) copper arsenite, which can be used only in a dilute ammoniacal solution in open tank treatment. Six veneers for each concentration of the five wood preservatives (including creosote) were treated and two pieces of each (treated with the same concentration of chemical) were laid in three different localities. The tests have been in progress for about 9 months, and the veneers have been exposed to 70 to 80 inches of rainfall. The latest available results at the three different localities are remarkably similar. Also, the destruction of the veneers has proceeded progressively from those treated with the lowest concentrations to those with the higher concentrations (up to a critical limit) where there has been practically no further attack for some time. The ASCU wood preservative has so far given the best results for a unit of money. Some of the veneers treated with 40 per cent. creosote perished in even less than six months; such a concentration corresponds to 2 per cent. to 3 per cent. of ASCU which has already protected the veneers for over 9 months.

To determine the approximate quantities of the wood preserving chemicals noted above, for equivalent effectiveness (irrespective of the cost factor) in protecting wood against fungus and white ant attack, and in order to investigate the effect of species on critical toxicity concentration, $\frac{1}{8}$" sliced veneers of sapwood pine (*Pinus excelsa*) were treated with different concentrations of the chemicals and laid in the "test-yard" of the Section. Even after about 8 months, during which period they were exposed to about 50 inches of rainfall, very few of the veneers (compared with those of semul similarly treated) have been destroyed. The untreated controls perished in 2 to 3 months compared with those of semul which were destroyed in about a month.

6. *Small Scale Service Tests with Arsenicals and other Preservatives.*

In last year's annual report, a list of substances which were submitted to test with arsenicals and other wood preservatives was given.

The experiment has recently been closed, and the following indications may be deduced from the results:—

(*a*) Creosote, Falkamesam, copper sulphate (fixed or unfixed) and mercuric chloride gave the best results. Copper sulphate and mercuric chloride appeared to be the most effective against termites, but neither of these, *per se*, can be employed in pressure treatment.

(*b*) Arsenic in the trivalent form appears to be slightly better than in the pentavalent form.

(*c*) Of the other arsenic compounds tested, arsenic trioxide, colloidal arsenious trisulphide, and zinc-meta-arsenite, gave better results than Powell solution and Thanalith U, both of which exhibited a rather poor degree of resistance to fungus and white-ant attack.

(*d*) The least effective termiticides of the chemicals tested were sodium dichromate, zinc chloride, sodium fluoride and barium hydroxide.

(*e*) Fuel oil gave poor results. A piece of semul treated with 20 per cent. fuel oil was destroyed in less than 9 months. In the form of veneers, 20 per cent. fuel oil may be expected to give way in a few weeks for the same absorption per unit volume.

(*f*) Creosote fractions distilling at over 260°C were decidedly superior to the lighter fractions.

(*g*) Some of the creosote and crude oil (1 : 1) treated pieces were moderately or badly attacked although they were treated with a 20 per cent. solution of the mixture.

(*h*) Pieces treated with straight creosote were sound over an 8 per cent. concentration.

The size of pieces used in this test appeared to be too large, and had other disadvantages.

7. *Relative Efficacy of Wood Preservatives to Termites and Wood Destroying Fungi.*

Experiments are in progress to investigate this important question as, in most cases, wood is destroyed by the con-joint and synchronous action of termites and fungi. It has been found that generally a larger quantity of chemical is required for protection against white ants when the wood is initially fungus-attacked. As in practice, there is almost always a certain degree of fungus attack in wood, it becomes a moot point, especially where there is a danger of termite attack, as to whether toxicity tests should not be conducted with fungus-attacked instead of sound test specimens. There are a number of complicated aspects which require investigation in this connection, and a start in this direction was made. It is expected that results of some value will be reported in next year's report.

8. *Project IV and Grave-Yard Tests.*

Some of the *Parashorea stellata* sleepers from Burma were treated during the year.

During the year, the following were added to the standard grave-yard test of the Section.

1. Sundeala fibre board.
2. Sawdust and cement composition.
3. Creosoted sal pieces.
4. Fibre boards.
5. Insulation boards.
6. Shalco.
7. Standard canvas (treated).
8. Treated bamboo.
9. ASCU.
10. Wood oil.

Untreated specimens of the following species were added during the year :—

1. *Podocarpus wallichianus.*
2. *Artocarpus integrifolia.*
3. *Mallotus philippinensis.*
4. *Miliusa velutina.*
5. *Stereospermum xylocarpum.*
6. *Bassia butyracea.*

All the untreated specimens in the grave-yard were inspected twice during the year, and the treated pieces once after the rains. Reports were sent out to all Government authorities and firms interested.

Reports on the pieces of wood that were treated with different wood preservatives and shaken 20,000 times with water, and then laid in white ant infested ground in several parts of India, indicate the superiority of Falkamesam over other arsenical preservatives. ASCU, on account of its being a development of and an improvement on Falkamesam, may be expected to give even better results. All the Falkamesam-treated sticks planted in the grave-yard about twenty-two month sa go ,are intact. This is unique for a water-soluble preservative, as with none of the many other water-soluble preservatives tested, (except for copper arsenite), were the treated pieces all sound even at the end of one year.

9. *Tests against Marine Organisms.*

ASCU, Falkamesam and creosote-treated pieces with corresponding controls are under observation in the Calcutta, Bombay and Madras harbours. Available reports to date indicate the efficacy of the preservatives in question.

10. *Miscellaneous Work.*

In the chemical laboratory, although the Section carried on without the Chemist of the section for about six months, miscellaneous work of considerable importance was conducted by the two laboratory assistants. In the experimental wood preservation plant, fence posts, paving blocks, and other material were treated with several kinds of antiseptics for a variety of experimental and utilitarian purposes.

11. *Publications.*

1. Forest Bulletin No. 85 entitled "A record of the results obtained with experimental treated sleepers laid in the Indian Railways between 1911 and 1916" was sent to the press.

2. The Officer in Charge of the Section was awarded H. E. the Viceroy's prize of Rs. 500 by the Institution of Engineers (India) for his paper on "A new principle in wood preservative impregnation with special reference to chir pine"; the paper was based on some experimental work done in the Wood Preservation Section a few years ago.

Wood Workshop Section.

This Section continued to function on a reduced scale as a supply unit for other Sections, while the Officer in Charge devoted the greater part of his time to veneer and plywood research and to glue testing.

The Timber Testing Section was supplied with 10,875 wood specimens for test purposes.

The Wood Technology Section was supplied with 33 Gamble and 620 hand specimens of 25 species.

486 orders of maintenance and routine work were booked, and 468 orders (including 65 from the previous year) were completed.

195 logs of the following species were converted in the sawmill :—

Podocarpus wallichianus (thitmin) for strength tests.

Mallotus philippinensis (*roini*) for strength tests.

Mimusops elengi for strength tests.

Miliusa velutina (*dom-sal*) for strength tests.

Castanopsis hystrix (*katus*) for strength tests.

Stereospermum xylocarpum (*vedang komai*) for strength tests.

Parishia insignis (red dhup) for strength tests.

Shorea robusta (sal) for strength tests.

Bassia butyracea (hill *mohwa*) for strength tests.

Vitex altissima (*milla*) for strength tests.

Dalbergia latifolia (Indian rosewood) for strength tests.

Xylia xylocarpa (*irul*) for strength tests.

Pterocarpus santalinus (red sanders) for strength tests.

Lagerstroemia lanceolata (benteak) for strength tests.

Terminalia tomentosa (laurel) for seasoning tests.

Hardwickia pinnata (piney) for seasoning tests.

Schima wallichii (needle wood) for seasoning tests.

Anogeissus latifolia (axlewood) for seasoning tests.

Dichopsis elliptica (*pali*) for seasoning tests.

Dalbergia latifolia (Indian rosewood) for general use in the Wood-Working Section.

Cedrela toona (toon) for general use in the Wood-Working Section.

Dalbergia sissoo (sissoo) for general use in the Wood-Working Section.

Mangifera indica (mango) for general use in the Wood-Working Section.

Pinus longifolia (chir) for general use in the Wood-Working Section.

Tectona grandis (teak) for general use in the Wood-Working Section.

Terminalia tomentosa (laurel) for test in the Wood-Working Section.

Grewia tiliaefolia (dhaman) for test in the Wood-Working Section.

Hopea parviflora for test in the Wood-Working Section.

Xylia xylocarpa (*irul*) for test use in the Wood-Working Section.

Anogeissus latifolia (axlewood) for test use in the Wood-Working Section.

Pinus longifolia (chir) for test in the W. P. Section.

Cedrela toona (toon) for veneer tests.

Dalbergia sissoo (sissoo) for veneer tests.

Artocarpus hirsuta (*aini*) for veneer tests.

Ougeinia dalbergioides (*sandan*) for veneer tests.

Chukrasia tabularis (chickrassy) for veneer tests.

Pterocarpus marsupium (*bijasal*) for veneer tests.

Dalbergia latifolia (Indian rosewood) for veneer tests.

Pinus longifolia (chir) for use in the Paper Pulp Section.

Dalbergia sissoo (sissoo) for flooring in the Forest Research Institute.

In addition to the above, 2,358 paving blocks were converted from old sleepers for flooring the timber godowns, 753 paving blocks were cut from sleepers for use in the W. P. Section, 350 maunds of firewood

were cut for making charcoal for briquetting experiments and for use in the new F. R. I. kiln, 200 ballies were converted into 430 posts for the Rangers' College, 4 sleepers were squared for the Wood Seasoning Section, 3 special test blocks (glued planks) were made for experiment in the Veneer Section, 1 plank of *Terminalia tomentosa* (laurel) was specially cut into five veneers, 7 planks of *Swietenia mahogoni* (mahogany) were cut into 14 veneers for general use in the Wood-Working Section, 1000 crossers were prepared from off-cuts for the Seasoning Section, and 7 lorry loads of firewood were cut for stock.

A large number of enquiries were received from various sources which were replied to.

Tests.

Tests on glues and plywood were carried out as follows and results submitted to :—

1. The Aircraft Inspector, Karachi, on samples of casco waterproof glue and casco No. 2 white glue.
2. The Divisional Forest Officer, Nowgong Division, Nowgong, on the conversion qualities of Nowgong town teak.
3. The Assistant Aircraft Inspector, Civil Aerodrome, Dum Dum, on a sample packet of ' held ' glue.
4. Messrs. Bird & Co., Calcutta, on *Dipterocarpus macrocarpus* (hollong) plywood.
5. The District Forest Officer, North Mangalore, on the working qualities of two samples of *Artocarpus integrifolia* (jack).
6. Master-General of the Ordnance Branch, Army Headquarters, Simla, on five plywood pieces of chir and deodar.
7. The District Forest Officer, Upper Godavari Division, Madras, on two logs of Godavari teak sent for green test under Project VIII.

General.

Experiments were also carried out with a view to finding a waterproof coating for the edges of plywood exposed to the elements. A report was issued.

Tests were carried out on the undermentioned glues supplied by Aircraft Inspectors :—

Casein Cement 3 V. 2.

Casco Waterproof Glue.

Casco No. 2 White glue.

' Held ' Glue (Liquid).

Logs of the following species were peeled for tests under Project VIII :—

Tectona grandis.

Swintonia floribunda.

Parashorea stellata.

Anisoptera glabra.

The number of species now tested under this Project amounts to about sixty.

Experimental 'Quickfold' collapsible packing cases were made and supplied for trial to the Railway Board, Simla, and to the Inspector of Gun Carriages and Vehicles, Jubbulpore. This work is being continued.

Reports.

Reports on the working qualities of the undermentioned timbers were issued during the period under review :—

Podocarpus wallichianus.

Stereospermum xylocarpum.

An interim report on the work done up to the end of 1933 under Project VIII (testing of veneers and plywood) was written up before the end of the year and will be published shortly.

Minor Forest Products Section.

1. *General.*

The Forest Economist is nominally in charge of this Section, and the total staff of the Section consists of one Upper Grade Assistant (Mr. Ramaswami), one laboratory assistant and 3 or 4 coolies. With such a staff it is evident that very little research work can be accomplished. The year under review has from a research point of view being practically wasted, as the time of the Assistant has been almost completely taken up in answering enquiries about minor products. The chief items of work undertaken by the Section are as follows :—

2. *F. R. I. Portable Charcoal Kiln.*

Scale drawings of the kiln were sent to various firms of manufacturers in India asking for quotations. They were informed at the same time that the Forest Research Institute would not take any part in the sale and that the main idea was to put the kiln on the market at the lowest possible price. The lowest quotation received was Rs. 535 each for an

order of not less than 12 kilns at a time, but it is possible that those who intend to use the kiln could get it made for less than this.

Great interest is being taken in the kiln by forest officers and charcoal contractors if the numerous enquiries received on this subject is any criterion. The working of the kiln was also demonstrated to two forest officers and to a charcoal contractor who came to the Institute for that purpose.

A note embodying details of and the results of the working of the kiln is under preparation.

3. *Charcoal Briquetting.*

Further large scale experiments on charcoal briquetting were handicapped for want of a charcoal grinding machine. A grinding machine was purchased towards the close of the year and more progress will be possible after its erection.

4. *Bamboo branches for umbrella handles.*

At the instance of the U. P. Forest Department and a firm of umbrella manufacturers, some experiments were started in conjunction with the Seasoning Section, to find out whether bamboo branches could be bent for use as umbrella handles. As material of the requisite size could not be obtained locally, the enquirers were asked to supply samples. It is doubtful whether large quantities of bamboo branches of a suitable thickness for use as umbrella handles could be obtained, as they have a tendency to taper too much, though they may be of the right thickness at the base.

5. *Minor Forest Products Garden.*

During the year, roughly half the area of the old Minor Forest Products' garden was handed over to the Forest Botanist for the new Botanical garden. At the same time the extensive nurseries of the Botanist will be used for the cultivation of medicinal plants in fair sized beds, to determine whether the yield and quality of such drugs can be improved by cultivation. This will form an important part of the work of the Minor Forest Products Section in future.

As regards medicinal plants already under cultivation in the garden, some seeds were collected from the *Artemisia maritima* plants sown last year, and these acclimatised seeds were again sown this year. Germination was poor, but enough plants have been obtained for planting this year. Propagation by stem cuttings was tried and found to be successful, but it is too early to pronounce any opinion on this till after the monsoon. Experiments have shown that *A. maritima* seeds stored for a year lose their power of germination.

Psyllium (*Plantago psyllium*, L.) which was sown in March during the previous year grew vigorously but failed to flower. Its cultivation was continued this year, the sowing being made in October-November. The growth was good and the plants were flowering and fruiting at the end of the year (March 1934), and it is hoped that the seeds will be ripe before the monsoon sets in.

A list of medicinal plants suitable for cultivation in the Minor Forest Products garden was prepared and sent to Lt. Col. Chopra, Professor of Pharmacology in the School of Tropical Medicine, Calcutta, for his opinion. The reply was received after the close of the year. About 2 dozen plants chosen from his list will be cultivated during 1934-35.

6. *Enquiries.*

Numerous enquiries dealing with sources of supply, collection, marketing, prices, etc., of various minor forest products were answered during the year, in fact this part of the work is now so heavy that it takes up practically the whole time of the only officer in the Section.

Paper Pulp Section.

1. *Experimental Factory.*

As a measure of fuel economy, the steam boilers were shut down at three different times during the year for a total period of about 16 weeks, necessitating suspension of work in the experimental paper factory.

(*a*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos in the Norris and Christy machine were continued during the year under report. It was found necessary to effect a number of modifications in the machine in order to obtain (without appreciable loss of the material as dust or fine particles) satisfactory chips, which could be completely digested in the factory. In the case of thick or solid bamboos it was found helpful to split the culms and partially crush the nodes prior to digestion. Experiments, to devise suitable means to effect this and also to determine the output of the machine, the power consumption, and the loss of material, etc., will be carried out next year.

(*b*) *Dendrocalamus hamiltonii* (*kokwa*) *bamboo.*—A few semi-commercial tests on this bamboo were carried out, employing the sulphate process by the fractional method. The tests appear to confirm last year's laboratory results as regards yield and bleachability. Further tests to determine the optimum conditions of digestion and to obtain the maximum yield of pulp are in progress. The present report is printed on paper made from this bamboo, which fact speaks for itself as to its suitability as a paper-making material.

(*c*) *Ochlandra brandisii* (*eta*) *and Melocanna bambusoides* (*muli*) *bamboos.*—Experiments on these bamboos were carried out to prepare special pulp suitable for artificial silk manufacture. As consistent and markedly improved results, as regards alpha cellulose content, were not obtained, it is proposed to repeat the experiments.

(*d*) *Saccharum spontaneum* (*kans*) *grass.*—A number of experiments were carried out on this grass, with the help of the rod mill, to obtain easy bleaching pulp, but the pulp obtained was not free from shives and the yield was also low. It is proposed to repeat the experiments, modifying the processes of digestion and bleaching, if necessary.

Efforts to produce wrapping paper from the grass were also unsuccessful, as the paper obtained was full of shives and poor in strength.

(*e*) *Flax waste.*—Laboratory experiments carried out during the year before last had indicated that this material was excellent for paper-making purposes. Semi-commercial tests were, therefore, undertaken to confirm the laboratory results. It was found necessary to grind the material after predigestion. The rod mill in the factory, however, proved unsuitable for the purpose, as the woody cores, embedded in the tangle of long fibres, escaped thorough crushing, with the result that the bleached pulp contained some shives, though its yield was quite satisfactory. It is proposed to arrange for the predigestion and the grinding of the predigested material at the paper mills at Lucknow, where facilities exist for the purpose.

(*f*) *Pinus longifolia* (*chir*).—Experiments were carried out for the production of (1) kraft paper and (2) bleached papers from this pine. The material produced an excellent kraft paper, but the bleached pulp obtained from it was not clean and was also low in yield. Experiments on this material will be continued next year.

(*g*) *Manufacture of paper.*—About 1¼ tons of writing, printing, type and kraft papers, and mounting and drying boards, were manufactured in the factory during the year and supplied to the various offices of the Forest Research Institute and College.

2. *Laboratory.*

(*a*) *Preparation of pulp for artificial silk.*—Experiments on the purification of bamboo pulp, to render it suitable for artificial silk manufacture, were continued throughout the year. It was found possible to prepare a pulp with 96 per cent. alpha cellulose and 0·2 per cent. to 0·3 per cent. ash content. Trials of the method which gave these results will be carried out on a semi-commercial scale next year.

(*b*) *Chemical analyses of raw materials.*—Determinations of cellulose, lignin, pentosans, ash, caustic soda solubility, etc., were made with :—

(1) *Saccharum spontaneum.*

(2) *Pinus longifolia.*

(3) *Dendrocalamus strictus* bamboos from Bihar and Orissa (analyses still in progress).

(*c*) *Tests on savannah grasses from Assam.*—The following eight grasses* from the Goalpara division of Assam were tested as to their suitability for pulp and paper making :—

(1) *madhauli*, (2) *baranga*, (3) *ulu*, (4) *bata*, (5) *majra*, (6) *baranga-tanga*, (7) *malsa* and (8) *khagra.*

The grasses were found to possess fairly long fibres (3-4 mm.), and the consumption of chemicals for digestion and bleaching was also found to be within economic limits; but the percentage yields of pulps were very low, varying from 22 to 26·5. The grasses, therefore, though suitable for paper-making, cannot economically be used for the purpose, unless available at very low prices.

(*d*) *Tests on Saccharum spontaneum* (*kans*).—Preliminary tests to determine the optimum conditions of digestion on a large scale, so as to obtain clean and easy bleaching pulp, were carried out on this material.

(*e*) *Straw-boards from sabai grass* (*Ischoemum angustifolium*).—Experiments on the preparation of fairly non-absorbent straw boards from the grass were carried out at the request of Messrs The Straw Board Manufacturing Co., Saharanpur. Satisfactory samples were prepared and supplied to the firm for trial and opinion.

(*f*) *Lantana wood.*—Tests were carried out on this wood at the request of the Madras Forest Department. The yield of pulp from the material was satisfactory, but the fibre length was found to be very short. The pulp from the wood can at best be used as a filler in the manufacture of papers from bamboo pulp, etc.

(*g*) *Tests on miscellaneous materials.*—(i) *Diospyros melanoxylon* leaves were tested for the production of papers for use in the manufacture of *beedies* (country cigarettes).

(ii) *Vetiveria zizanioides* (*khar* grass) was tested for its paper-making qualities. The yield of pulp from it was found to be very poor.

(iii) Whole linseed straw was tested for the production of straw-boards. The results obtained were very satisfactory.

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* The correct scientific names of the grasses are not yet known.

(*h*) *Boiler feed water.*—Routine analytical tests in connection with the softening of the boiler feed water were carried out as and when required.

3. *Technical Information and Advice.*

(*a*) The Paper Mill at Jagadhri was visited in September 1933 in order to report on the capacity and the condition of the existing plant to a private syndicate interested in undertaking the operation of the mill.

(*b*) Suggestions and advice were given to Messrs The Upper India Couper Paper Mills, Lucknow, with regard to new plant and to changes in the existing plant, considered necessary to increase the efficiency and output of the Mill.

(*c*) Correspondence was carried on with private individuals, commercial firms and Government departments in connection with 22 *technical inquiries referred to the Section.*

4. *Bamboo Pulp Projects.*

Although no new bamboo projects materialised during the year under report, bamboo has been finding increasing use in existing mills. Messrs The Titaghur Paper Mills are using over 15,000 tons of bamboo per annum, which is partly responsible for their reduction in the consumption of *sabai* grass. Large quantities of this grass are thus available now, particularly from the Western Circle, U. P., for the use of the mills at Lucknow and Jagadhri. It is understood that Messrs The India Paper Pulp Co. have installed a new type of chipping and disintegrating plant for bamboo. The performance of this plant will be watched with interest.

Mechanical Sub-Section.

This auxiliary Sub-Section functioned most satisfactorily throughout the year under the guidance of Mr. Ram Das Tandan, the Mechanical Engineer and B. B. L. Saksena his Electrical Assistant.

One laboratory kiln on the principal of internal circulation, and two laboratory kilns with constant humidity chambers, were constructed for the Seasoning Section. Several modifications were carried out on the disintegrator installed 2 years ago in the Paper Pulp Section with a view to adapting this machine for disintegrating bamboos. A shaking machine was also made and installed in the Wood Preservation laboratory.

The steam boilers, the Institute lorries, the fire extinguishing appliances and other plant were kept in proper working order throughout the

year. The 150 K. W. direct current generating sets and all electric motors, both big and small, as well as the electric ovens installed in the various workshops and laboratories of the Institute, were maintained in good order.

The total number of mechanical and electrical jobs carried out in the mechanical repair workshops during the year amounted to 450. These included the overhauling and repairing of machines and lawn mowers, as well as the repairing and re-winding of electric motors, starters and electric ovens.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A. Drugs :—

i. *Actinodaphne hookeri*, Meissn.
ii. *Artemisias.*
iii. *Bombax malabaricum*, DC.
iv. *Derris* spp.
v. *Spatholobus roxburghii*, Bth.
vi. *Tephrosia candida*, DC.
vii. *Strychnos nux-vomica*, Linn.
viii. *Vitex negundo*, Linn.

B. Essential oils :—

Santalum album, Linn.

C. Oils and Fats :—

i. *Cinnamomum camphora*, Linn.
ii. *Litsæa zeylanica*, Nees.
iii. *Melia azedarach*, Linn.
iv. *Quercus incana*, Roxb., *Q. dilatata*, Lindl., and *Q. ilex*, Linn

2. Study of forest soils.

3. Miscellaneous enquiries.

I. A.—Drugs.

(i) *Actinodaphne hookeri*, Meissn.—It was reported in 1931-32 that an alkaloid *actinodaphnine* had been isolated from the bark of this tree and that a preliminary chemical study had been made. Further work on the chemical constitution was carried out in collaboration with Dr. Schlittler of the Oxford University. The alkaloid has now been found to be a secondary base of the formula $C_{18}H_{17}N\,O_4$ and closely related to *laurotetanine*, *dicentrine* and other *aporphine* bases. That it contains a phenanthrene nucleus has been shown by its oxidation and methylation products, and the position of the four oxygen atoms in the molecule has

been indicated by the detection of a methoxyl, hydroxyl and a methylene-dioxy groupings. These have led to our assigning to *actinodaphnine* an aporphine structure, but there still remains uncertainty regarding the relative position of the hydroxyl and the methoxyl groupings in the molecule.

(ii) *Indian Artemisias.*—During the last few years attention had been concentrated on *Artemisias* from Kashmir and Kurram valleys but this year the investigation has been extended to *Artemisias* found in Tehri-Garhwal, Kagan, Kulu, Upper Bashahar and Malakand, with a hope of discovering the santonine bearing species. This hope has not been realised as all the samples, from the above localities, were found to be santonine free.

It was reported last year that attempts to grow, in Dehra Dun, *Artemisia maritima* from the seeds obtained from Kurram valley had been successful and that the santonine content in the second year of its growth was almost as high as in plants growing in their natural habitat. Similar attempts have now been made on Kashmir *Artemisias* (*A. brevifolia*) and the results obtained are recorded below :—

Time of collection.	Santonine percentage.	Remarks.
4th week of August 1933 . . .	0·00	leaves only.
4th week of October 1933 . . .	0·66	
4th week of October 1933 . . .	0·69	buds only.
1st week of December 1933 . .	0·01	leaves and buds.
1st week of January 1934 . . .	0·78	
1st week of February 1934 . .	0·12	
1st week of March 1934 . . .	0·66	fresh leaves.

The data given above indicate that in the first year of its growth, in Dehra Dun, in the plants raised from Kashmir *Artemisia* seeds, the buds formed rather late (October) and they matured in November-December, shifting thereby the period of maximum santonine content to early in December. In its natural habitat, on the other hand, August is the period of maximum santonine content, the buds appearing in May. (Simonsen, *Jour. Ind. and Labour* 1921, 1; 539.) It is, however, possible that when the plants get acclimatized, the period of maturity might shift back again to June-July, that is prior to the monsoon, as in the case of the Kurram *Artemisias*.

(iii) *Bombax malabaricum*, DC. *vern. Semul.*—Tap roots of the young plant known as *musli*, according to books on the Indian system of medicine, enjoy great reputation as a powerful aphrodisiac and tonic, but it appears that its medicinal properties have been exaggerated. Chemical examination showed it to contain moisture, 7·5; ash, 2·1; proteids, 1·2; fatty matter, 0·9; phosphatide, 0·3; colouring matter, 0·5; tannins, 0·4; non-tans, 0·1; sugars, 8·2; starch, 71·2; pectus matter, 6·0 and cellulose 2·0 per cent. No glucoside or alkaloid was detected. Analyses of tubers of different ages showed that the proportion of the above constituents varied with the age of the roots. In younger ones sugar, starch and pectus matter predominated whereas in the maturer ones, tannin and cellulose.

None of the above constituents, excepting the phosphatide, was considered the likely substance responsible for the reputed medicinal properties. The phosphatide, which is associated with fatty matter, was expected to be lecithin, a common constituent of many plant materials; but a detailed examination showed it to be a cephalin like substance, practically insoluble in absolute alcohol and acetone but freely soluble in dry ether. This observation is interesting in so far as cephalin is not regarded as a common constituent of plant tubers. Literature records only one case of cephalin having been discovered in soya beans.

The fatty matter is an orange coloured, thick viscous oil of the following constants—Refractive Index, at 20°C, 1·4747; Iodine Value, 63·5 and Saponification Value, 210·4. It appeared to have the usual constituent acids. Search was also made for vitamines A, D and E but without success.

The mucilage appears to be a silico-phosphoric ester of manno-galactan. The occurrence of phosphoric and silicic ester of a polysaccharide in nature is not uncommon. For example, it has been reported that the mucilage of the seeds of fenugreek (*Trigonella fœnum graccum*, Linn.) is a salt of silico phosphoric ester of manno-galactan. It is possible that the mucilage, besides the phosphatide, is to some extent responsible for some of the effects of the drug since it is reported by some medical practitioners "to be a good demulcent tonic possessing some soothing action on the mucous membrane of the genito urinary tract but nothing beyond."

(iv) *Derris* spp.—It was reported last year that roots and twigs of *Derris uliginosa* (collected in Sundarbans in November 1932) were, unlike those of *D. elliptica*, very poor in ether solubles. The roots did not yield any weighable quantity of rotenone although the ether extract gave the characteristic colour reaction. (Jones and Smith, *Ind. and Eng. Chem. An. Ed.* V, 75). Another sample of roots collected from the same

locality in June 1933 was also very poor in ether soluble extractives, giving the colour test for rotenone but from which no rotenone could be isolated. Ether extract of twigs, in either case, gave no reaction for rotenone. A further sample from the same locality, collected in October 1933, also failed to yield any rotenone. From this it might be concluded that there is no seasonal variation of the rotenone content or allied substances (ether extractives) in *D. uliginosa*.

A sample collected in October 1933 from Chittagong division was analysed but was not found to be superior to the samples from Sundarbans, results for which are recorded above. In this case also no rotenone could be isolated even though a distinct colour reaction was obtained. Attempts to isolate other insecticidal bodies, allied to rotenone, such as deguelin and tephrosin were unsuccessful. These results lead to the conclusion that *D. uliginosa* cannot be considered as a good insecticide since it contains practically no rotenone, deguelin, tephrosin or other allied bodies and whatever feeble insecticidal properties it is supposed to possess are possibly due to the resinous bodies present in it.

Derris elliptica.—Only one sample has so far been examined and this was collected in June 1933, from Dibrugarh, Assam. It yielded 2·5 per cent. of ether solubles of which 0·8 per cent. was rotenone. This sample although of poor quality, when compared to Malayan *Derris* of 7-8 per cent. rotenone content, is the first sample of rotenone bearing *Derris* of purely Indian origin that we have examined in this Institute, and it is hoped that with cultivation and care it might be possible to raise better quality roots. Search is being made for *D. elliptica* in other parts of Assam and samples are being awaited.

Derris robusta, Bth.—Roots and twigs were obtained from Kamrup division, Assam, in October 1933. The analyses showed it to contain 4·7 per cent. of ether solubles of which 1·2 per cent. was a crystalline substance, which on purification was obtained in stout prismatic needles m.p. 195°-196°C. It gave no colour tests for rotenone. Complete identification of this substance has not yet been possible but it appears to be tephrosin, a substance allied to rotenone and is likewise poisonous to insects. From the resinous matter another light yellow crystalline substance was obtained which on purification melted at 171°-172° and which appears akin to deguelin (m.p. 174°-175°), another insecticide. No rotenone could be isolated, nor was any colour reaction obtained from the ether extracts. The nature of these crystalline substances is being investigated further.

(v) *Spatholobus roxburghii*, Bth.—Jones (J. A. C. S. *55*, 1737) reported that about 1 per cent. of rotenone is present in the root bark of the samples obtained from Burma. The samples of *Spatholobus* collected locally in June and September were examined, but neither the root bark

nor the woody portion showed any presence of rotenone or allied substances.

(vi) *Tephrosia candida*, DC.—It is an allied species to *Caracca verginiana* found in U. S. America, which has been reported to contain rotenone, deguelin and tephrosin. Roots of *T. candida* growing in the Institute were examined and although 0·9 per cent. of ether extract, containing 0·2 per cent. of a crystalline substance m.p. 230°C was isolated, no test for rotenone was obtained. It is intended to examine a few more *Tephrosia* spp. before rejecting it as unfit for insecticidal purposes.

(vii) *Strychnos nux-vomica*, Linn.—It was reported last year that *nux-vomica* seeds are frequently adulterated with spurious seeds of *S. nux-blanda* which do not contain any strychnine but which resemble the genuine strychnos seeds in appearance when properly made up. Chemical assay of the seeds is a lengthy procedure and the saving of time is an important factor especially when large quantities of material have to be purchased. A single chemical assay is hardly of any value as the *nux-blanda* seeds might not be uniformly mixed in all the bags of the same consignment. A search, therefore, was made for a quick method of distinguishing the two species. For this purpose the seeds were examined under ultra violet light from a mercury vapour lamp, fitted with Wood's filter. The *nux-vomica* seeds show a dull brown fluorescence and the *nux-blanda* seeds a slightly lighter shade. This distinction is not of much significance but when split seeds were examined, both showed a brilliant fluorescence: *nux-vomica* giving bluish and *nux-blanda* pink. This distinction becomes greatly marked and the depth of colours are clearly brought out when viewed under mixed light namely the ultra violet light and the ordinary electric light. It has been possible in this way to distinguish the two species of seeds.

(viii) *Vitex negundo*, Linn. vern. *nirgundi*.—Is a herb, common throughout India and well known in the Hindu system of medicine. The leaves are reported to be useful in sprains and rheumatism and the roots as tonic, febrifuge and expectorant (*Pharm. Ind.* Vol. III, p. 72). Chemical literature records nothing about the constituents of this plant and, therefore, its investigation was taken up. Air-dried powdered leaves (moisture 13 per cent.) gave 8·9 per cent. to petrol; 1·4 per cent. to ether; 0·6 per cent. to chloroform; 2·6 per cent. to ethyl acetate and 8·9 per cent. to alcohol. About 0·03 per cent. of an unidentified alkaloid has also been obtained.

The alcoholic extract, on standing, deposited a white crystalline substance m.p. 196°-98°C which was found to be a polyhydric alcohol. Further treatment of the alcoholic extract gave two acids one melting at 220°C, crystalline needles and the other melting at 184°-85°C, crystalline

needles giving greenish blue colour with ferric chloride and deep yellow colour with alkalis. A glucosidal substance has also been isolated and this on hydrolysis with acids yields the crystalline substance m.p. 220°-21°C. Further work on these products is in progress. The glucoside and the acidic substance described above appear to be the active constituents of the leaves and might be responsible for their therapeutic value.

I. B.—*Essential oils.*

Santalum album, Linn.—For commercial classification it is sorted into 18 different grades based on size, quality, physical appearance, etc., but without any reference to their oil content. The oil content, however, is an important consideration and no reliable information is available on this subject especially for the Madras and Coorg sandal wood and hence the present investigation, at the suggestion of the Chief Conservator of Forests, Madras.

For purposes of sampling a single tree was selected in each locality and from its different parts different commercial grades of wood, namely *ghatbadla*, *cheria*, roots, *basola bukni*, etc., were extracted in accordance with the usual practice and the oil content determined. The results obtained are tabulated below. From this it will be noticed that commercial classification based on weight and physical appearance has no intimate connection with the oil content and, speaking generally, the roots contain a much higher amount of oil than the stems and branches. It will also be noticed that *ainbagar* and *cheria* which consist of thinner billets from stems and branches, are often richer in oil content than the thicker parts of the stem represented by *ghatbadla* and *bagardad*. It is, therefore, obvious that when the wood is to be used for purposes of distillation of the oil, the present system of classification has no significance.

Oil content of different grades of Sandal wood from Coorg and Madras.

Commercial classification of sandal wood.	Description.	Locality.					
		Coorg.	Salem.	Kollegal.	Vellore.	Tinnevelly.	Mangalore.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Ghatbadla .	Billets with knots and cracks and hollows weighing not less than 16 lbs.	6·6	6 6	6·1	5·3	3·4	5·4
2. Bagardad .	Solid pieces without special reference to weight and number.	6·3	..	..	..	..	..

Oil content of different grades of Sandal wood from Coorg and Madras—(contd.)

Commercial classification of sandal wood	Description	Locality.					
		Coorg	Salem	Kollegal.	Vellore.	Tinnevelly.	Mangalore.
		Per cent	Per cent	Per cent.	Per cent	Per cent	Per cent
3. Roots—							
Class I .	Pieces not less than 15 lbs.	8·5					
Class II .	Pieces not less than 5 lbs.	9·4	6·0	6·7	6·5	5·0	7·4
Class III .	Small lateral roots less than 5 lbs. *	10·1					
4. Jujpokal Class I.	Hollow pieces of not less than 7 lbs.	7·3	..	..	..	..	..
5. Jujpokal Class II.	Hollow pieces of not less than 3 lbs.	6·5	..	..	..	..	..
6. Alnbagar .	Solid cracked and hollow pieces of not less than 1 lb	8·0	..	..	..	..	..
7. Cheria .	Pieces and chips of heart wood not less than ½ lb.	6·1	7·1	7·1	6·5	..	6·1
8. Alnchilla .	Pieces and chips of heart wood.	6·6	..	..	..	..	..
9 Bassia Bukai.	Small mixed heart and sap wood chips.	1·0	1·8	5·2	2·5	2·4	2·1

NOTE.—The oil per cent. has been calculated on wood containing no moisture.
* Roots were not classified.

Sandal wood, as is generally known, is frequently adulterated with other woods which resemble it in appearance but contain no pleasant smelling essential oil in them. They are, however, capable of imbibing the odour and when left in contact with the genuine sandal wood, they begin to give out the scent. In this way cheaper and spurious woods are sold as genuine sandal wood, and it is a matter of great difficulty for a layman to make out a suitable distinction between the two. Attempt was, therefore, made to discover some simple and easy physical or chemical test for making this distinction. For this purpose, effects of various chemicals on sandal wood and also on its alcoholic extracts were tried and compared with those obtained, on similar treatment, from *Santalum spicatum*, *Mansonia gagei*, *Ximenia americana* and *Erythroxylon monogynum*, which resemble sandal wood in appearance and are often used as adulterants. For the above purpose, series of tests such as the following—determination of the hydrogen ion concentration of the aqueous extract of the ash, treatment of the alcoholic extract with acids, metallic salts, etc., were carried out and in this way it was found possible to differentiate the sandal wood from other species but a very much larger number of samples will have to be examined before a definite and an exact test is established. The great drawback of the present procedure is that it is far more elaborate than what would be desirable as a rapid field test.

I. C.—*Oils and Fats.*

(i) *Litsaea zeylanica*, Nees.—It was reported last year that the fat from the seeds of *Actinodaphne hookeri* contained about 96 per cent. of trilaurin. It was interesting to extend this study and make a search for other indigenous sources of lauric acid and for this purpose other species namely *Litsaea zeylanica* and *Cinnamomum camphora* allied to *Actinodaphne hookeri* were investigated.

The seeds of *Litsaea zeylanica* yielded 37 per cent. of endocarp and 63 per cent. of kernel and the latter on hot expression gave 33·5 per cent. of a pale yellow fat, crystallising in star shaped needles. Additional 24·5 per cent. of the fat was obtained on solvent extraction. The expressed fat had an iodine value 15·2 and saponification value 258·5. On crystallising from absolute alcohol it gave 70 per cent. of trilaurin.

(ii) *Cinnamomum camphora*, Linn. seeds gave 90 per cent. of kernels, which under hydraulic pressure yielded 39 per cent. of a pale yellow oil, setting hard on cooling and a further 26·5 per cent. was obtained on solvent extraction. The fat had iodine value 4, and appeared to contain trilaurin but in amounts much less than in *Litsaea zeylanica* seeds. Further work on this fat is in progress.

(iii) *Melia azedarach*, Linn. Persian Lilac.—In view of the reported medicinal value of the leaves, fruit, etc. of this tree and its similarity to the famous *neem* tree (*Azadirachta indica*) a chemical analysis of the kernel oil was undertaken. This investigation is in progress but the data collected up to date is given below :—

Moisture in the kernels	8·2 per cent.
Oil in the kernels by expression	13·5 „
Total oil in kernels	33·0
Iodine value (Hanus)	135·8
Refractive Index at 20°C	1·4688

(iv) Indian acorns (*Quercus incana*, Roxb., *Q. dilatata*, Lindl. and *Q. ilex*, Linn.).

Quercus grow all over the hills in Northern India and yield acorns in great abundance. At present, these find no commercial application because of the low content of oil in kernels and the poor quality of the tanning material in the "acorn cups" (Valonia of trade). In view of the absence of any chemical data on the oils, it was considered desirable to take up their investigation. Of about thirty species which occur in India, *Q. incana* (vern. *Bany*) is probably the best known and the oil from its acorns was therefore investigated in detail.

The kernels (81 per cent.) contained 16 per cent. of oil of the following constants :—

——	*Q. incana.*	*Q. dilatata.*	*Q. ilex.*
Consistency	thin	thin	thin
Colour	yellow	orange	orange
Specific gravity at 25°C . . .	0·9081	0·9084	0 9079
Refractive Index at 30°C. . .	1·4570	1·4588	1·4576
Saponification value . . .	192·2	188·4	189 9
Iodine value (Hanus) . . .	81·5	90·3	83·0
Acetyl value	14·8	21·1	17·1
Hehner value	96·1	88·2	94·9
Acid value	13·0	22·2	8·5
Unsaponifiable matter . . .	0·8%	2·3%	0 9%

Chemical constants of the mixed fatty acids of incana oil—

Mean molecular weight	285·2
Iodine value (Hanus)	80·8
Saturated acids	18·0
Unsaturated acids	82·0

Further examination of the acids indicated the oil to be a mixture of the glycerides of palmitic, lignoceric and oleic acids.

It has been reported by some workers that "dried acorns make a useful feeding material on account of their high starch content and digestible fibre. Drying the acorns is said to remove a great deal of the astringency which make fresh acorns impalatable and sometimes injurious to stock. At the same time they contain no substance injurious to poultry. Their food value is equivalent to a mixture of oats and maize. They may replace grain in poultry feed if their slight deficiency in protein is made up".

The analyses carried out in this Institute gave the following results for *Q. incana* kernels :—

> Moisture, 12·2 ; oil, 16 ; ash, 1·4 ; proteins, 3·0 ; cellulose, 1·4 ; tannins, 4·2 ; carbohydrate (by difference), 61·8 and 59·5 (by direct determination). No sulphur was detected.

The acorn cups in some of the Greek and Smyrna oaks are said to yield a high percentage (68 per cent.) of tannin (*Bull. Imp. Inst. 10,* 645) and they form a valuable source of commercial tannins. The cups

of the Indian acorns were, therefore, examined for this purpose and the following results were obtained :—

——	*Q. incana.*	*Q. dilatata.*	*Q. ilex.*
Moisture	12·1	11·1	11·8
Ash	3·0	2·1	2·6
Total solids (water extracts) . .	13·3	13·1	12 0
Tannins.	8·7	..	8·0

2. *Soils.*

Examination of the laterite soils from Assam and Chittagong has been made and also a large number of soils from experimental plots in the Institute have been examined for their moisture content.

3. *Miscellaneous enquiries.*

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and forest officers. Particular mention may be made of the following :—

Casein cements, glues, Eucalyptus and Palmarosa grass oils, Cinnamon bark, Katha, disinfectants, etc.

APPENDIX I.

PUBLICATIONS OF 1933-34.

Serial No.	Title of Publication.	Author.	Date of Issue.
	FOREST RECORDS.		
1	Entomological Investigations on the Spike Disease of Sandal (8) Carabidae.	H. E. Andrewes .	October 1933.
2	Entomological Investigations on the Spike Disease of Sandal (9) Neuroptera.	Nathan Banks .	July 1933.
3	Entomological Investigations on the Spike Disease of Sandal (10) Melasidae and Elateridae.	E. Fleutiaux . .	August 1933.
4	Entomological Investigations on the Spike Disease of Sandal (11) Fulgoridae.	N. C Chatterjee .	August 1933.
5	Entomological Investigations on the Spike Disease of Sandal (12) The Life History and Morphology of *Eurybrachys tomentosa*, Fabr. (Fulgoridae).	N. C. Chatterjee .	January 1934.
6	Entomological Investigations on the Spike Disease of Sandal (13) Membracidae and Cercopidae (Homopt.)—Supplementary Data.	N. C. Chatterjee and M. Bose.	December 1933.
7	Entomological Investigations on the Spike Disease of Sandal (14) Jassidae (Homopt.).	H. S. Pruthi . .	February 1934.
8	Entomological Investigations on the Spike Disease of Sandal (15) Cicindelidae (Col.) and Supplementary Data on Neuroptera and Elateridae (Col.).	N. C. Chatterjee .	February 1934.
9	Entomological Investigations on the Spike Disease of Sandal (16) Coccinellidae (Col.).	R. Korschefsky .	February 1934.
10	Entomological Investigations on the Spike Disease of Sandal (17) Coccinellidae (Col.), Supplementary Data.	N. C. Chatterjee and M. Bose.	February 1934.
11	Entomological Investigations on the Spike Disease of Sandal (18) Fulgoridae (Homopt.).	N. C. Chatterjee and M. Bose.	March 1934.
12	Entomological Investigations on the Spike Disease of Sandal (19) On the Life History and Morphology of *Petalocephala nigrilinea* (Jassidae, Homopt).	N. C. Chatterjee .	April 1934.
13	Entomological Investigations on the Spike Disease of Sandal (20) Studies on Insect Transmission.	Cedric Dover and M. Appanna.	May 1934.
14	Entomological Investigations on the Spike Disease of Sandal (21) Thysanoptera.	T. V. Ramakrishna Ayyar.	June 1934.
15	Entomological Investigations on the Spike Disease of Sandal (22) Formicidae (Hymen.).	Durgadas Mukerji .	May 1934.
16	A Stand Table for Sal (*Shorea robusta*) Evenaged High Forest.	I. D. Mahendru .	November 1933.
17	New Thysanoptera from India	Dudley Moulton .	November 1933.
18	Multiple Yield Tables for Deodar . . .	H. G. Champion and I. D. Mahendru.	November 1933.
19	Investigations on the Infestation of *Peridermium himalayense* on *Pinus longifolia*, Part II.	K. D. Bagchee .	November 1933.
20	Regeneration and Management of Sal . .	H. G. Champion .	November 1933.
21	The Physical and Mechanical Properties of Woods Grown in India, Third Interim Report on Project No. 1.	V. D. Limaye. .	November 1933.
22	Immature Stages of Indian Coleoptera (14)—(Curculionidae).	J. C. M. Gardner .	May 1934.
23	On the Biology of Mantidae	R. N. Mathur. .	May 1934.

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.	Date of Issue.
	FOREST BULLETINS.		
24	Testing and Selection of Commercial Wood Preservatives.	S. Kamesam . .	December 1933.
25	Measurement of Standing Sample Trees . .	H. G. Champion .	April 1934.
26	Provisional Yield Table for *Quercus incana*, Roxb. (*Ranj* or *Ban* Oak).	H. G. Champion and I. D. Mahendru.	July 1934.
27	Identification of the Commercial Timbers of the Punjab.	K. A. Chowdhury .	August 1934.
	OTHER PUBLICATIONS.		
28	Guide to the Forest Research Institute, Dehra Dun.	....	October 1933.
29	Progress Report of Forest Research in India, 1932-33, Part I.—The Forest Research Institute.	....	October 1933.
30	Progress Report of Forest Research in India, 1932-33, Part II.—Provincial Reports.	....	January 1934.
31	Tables for use with Brandis Hypsometer for Measuring the Height of Trees.	T. B. Manson and H. H. Haines.	November 1933.
32	Forty Trees Common in India	R. N. Parker . .	November 1933.
33	Progress Report of the Forest College, Dehra Dun, for 1932-33.	....	February 1934.
34	Annual Return of Statistics relating to Forest Administration in British India, for 1932-33.	....	July 1934.
35	Classified List of Officers of the Indian and Provincial Forest Services, and of the Forest Engineering Service in India and Burma, on 1st July 1933.	....	December 1933.

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Champion, H. G. . . European Silvicultural Research, Parts VI-IX. (*Indian Forester*, April, June, July, August, 1933.)

Champion, H. G. . . The meaning of crop diameter for the use of alignment chart (*Indian Forester*, December 1933).

Champion, H. G. and Mahendru, I. D. . . The Selection of Radii for Stump Analysis (*Indian Forester*, September 1933).

Champion, H. G. . . Underplanting in Teak Plantations (*Indian Forester*, May 1933).

Champion, H. G. . . The Effect of Thinning out Multiple Shoots on Young Root Stocks (*Indian Forester*, January 1934).

Champion, H. G. . . Seed Crop and Fertility of *Anogeissus latifolia* (*Indian Forester*, February 1934).

Gorrie, R. M. . . . Importance of the Origin of Seed used in Forestry (*Indian Forester*, April 1933).

Gorrie, R. M. . . . Plantations *versus* Reticulement (*Indian Forester*, September 1933).

Gorrie, R. M. . . . Recent Studies on Tree Roots (*Indian Forester*, March 1934).

Botany.

Parker, R. N. . .	Leguminosae and Root Nodules (*Indian Forester*, April 1933).
Parkinson, C. E. .	A New Burmese Bamboo (*Indian Forester*, November 1933).
Parkinson, C. E. .	Indian Species of Xylocarpus (*Indian Forester*, February 1934).
Parkinson, C. E. and Raizada, M. B.	Indian Wendlandias (*Indian Forester*, June 1933).

Entomology.

Beeson, C. F. C. .	Liability of solid bamboo lance staves to attack by borers (*Indian Forester*, November 1933).
Beeson, C. F. C. .	Control Measures for Termites (*Indian Forester*, January 1934).
Beeson, C. F. C. .	Prickly Pear and Coobineal Insects (*Indian Forester*, March 1934).
Beeson, C. F. C. and Chatterjee, N. C.	Quinquenial Survey of Investigations on Spike Disease of Sandal (*Indian Forester*, July 1933).
Gardner, J. C. M. .	The Early Stages of Two Indian Weevils (Col. Curculionidae) *Stylops*, Vol. II, 1933, pp. 81-5.
Mathur, R. N. .	Leaf-curl in *Zinnia elegans* at Dehra Dun (Reprinted from the Indian Journal of Agricultural Science, Vol. III, Part I, 1933, pp. 89-96).
Mathur, R. N. .	Notes on the Bionomics of *Odontomyia cyanea* Brunetti (Diptera: Stratiomyidae) (Reprinted from the Indian Journal of Agricultural Science, Vol. III, Part II, 1933, pp. 369-76).
Gardner, J. C. M. .	On Some Coleopterous Larvae from Uganda (Bull. Ent. Res.).

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Chowdhury, K. A. .	An Improved Method of Softening Hard Wood Tissues in Hydrofluoric acid under pressure (Annals of Botany, January 1934).
Chowdhury, K. A. .	The so-called Terminal Parenchyma cells in the wood of *Terminalia tomentosa* (*Nature*, Vol. 133, 10th February 1934, p. 215).
Bhargava, M. P. .	The Utilisation of Bagasse for Paper and Board Industry (*Indian Forester*, November 1933).
Ramaswami, S. .	Producer Gas from Charcoal (*Indian Forester*, February 1934).
Kamesam, S. . .	A Challenge to Steel and Concrete (*Indian Forester*, October 1933).
Nagle, W. . .	A Revolution in Panelling (*Indian Forester*, July 1933).
Seaman, L. N. .	The Practical Value of Laboratory Shrinkage Determinations (*Indian Forester*, June 1933).
Seaman, L. N. .	Joints used in timber framing (*Indian Forester*, January 1934).
Seaman, L. N. .	Tentative Grading Rules for Structural Timbers (*Indian Forester*, March 1934).

Chemistry.

Puntambekar, S. V. and Krishna, S.	The fat and the oil from the seeds of *Actinodaphne hookeri* Meissn. An indigenous source of Lauric acid. (Journal, Indian Chemical Society, 1933, p. 395).
Puntambekar, S. V. and Krishna, S.	The oil from the seeds of *Tectona grandis* (Teak). (Journal, Indian Chemical Society, 1933, p. 401).
Krishna, S. and Puntambekar, S. V.	Chemical examination of the tap root of *Bombax malabaricum*. (*In press*).

APPENDIX II.

PUBLICATIONS OF THE FOREST RESEARCH INSTITUTE, DEHRA DUN, AVAILABLE FOR SALE.

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		Statistical .	Mr. I. D. Mahendru	1-4-1933	30-4-1933
			Mr. M. A. Kakazai	1-5-1933	31-3-1934
Botany . .	Mr. C. E. Parkinson, Forest Botanist.	..	..	1-4-1933	31-3-1934
		Mycology .	Dr. K. D. Bagchee	1-4-1933	31-3-1934
Economy .	Capt. H. Trotter, Forest Economist.	..	..	1-4-1933	31-3-1934
		Minor Forest Products.	Capt. H. Trotter	1-4-1933	31-3-1934
		Timber Testing.	(Mr. V. D. Limaye)	1-4-1933	20-10-1933
			Mr. L. N. Seaman	21-10-1933	31-3-1934
		Wood Preservation.	Mr. S. Kamesam .	1-4-1933	4-8-1933
			(Capt. H. Trotter)	5-8-1933	15-8-1933
			Mr. S. Kamesam	16-8-1933	15-11-1933
			(Capt. H. Trotter)	16-11-1933	25-2-1934
			Mr. S. Kamesam .	26-2-1934	31-3-1934
		Seasoning .	(Mr. A. Rahman)	1-4-1933	24-4-1933
			Dr. S. N. Kapur .	25-4-1933	11-1-1934
			(Mr. A. Rahman)	12-1-1934	27-1-1934
			Dr. S. N. Kapur .	28-1-1934	31-3-1934
		Paper Pulp .	Mr. M. P. Bhargava	1-4-1933	31-3-1934
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1933	31-3-1934
		Wood Workshop	Mr. W. Nagle .	1-4-1933	2-3-1934
			(Capt. H. Trotter)	3-3-1934	31-3-1934
Entomology .	Dr. C. F. C. Beeson, Forest Entomologist.	..	..	1-4-1933	31-3-1934
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1933	31-3-1934
Biochemist .	Dr. S. Krishna, Biochemist.		...	1-4-1933	4-3-1934
	(Mr. T. P. Ghose)		..	5-3-1934	26-3-1934
	Dr. S. Krishna		..	27-3-1934	31-3-1934

APPENDIX IV.

ANNUAL FORM No. 24.

FOREST RESEARCH INSTITUTE.

Summary of Revenue and Expenditure of the Branches during 1933-34.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch	TOTAL.
1	2	3	4	5	6	7	8
REVENUE.	Rs	Rs.	Rs.	Rs.	Rs.	Rs	Rs.
V.—Miscellaneous—							
(*b*) Other sources . .	2,304	227	14	22	2,499	..	5,066
(*d*) Sale of timber and furniture from Seasoning and Wood Workshop Depot.	..	..	..	..	699	..	699
Total Revenue .	2,304	227	14	22	3,198	..	5,765
EXPENDITURE.							
A.—Conservancy, Maintenance and Regeneration—							
C.—Live stock, Stores, tools, and plant—							
C. 1.—Purchase of stores, tools, and plant	902	616	366	289	2,261	4	4,438
C 2.—Communications and Buildings, New Work.—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other works . .	..	..	..	..	..	..	..
C 3.—Communications and Buildings, Repairs and Maintenance—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other charges . .	505	..	..	..	..	..	505
C. 4.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	7,523	1,223	3,375	2,352	1,963	421	16,857
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	6,247	..	6,247
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	287	11,062	2,540	13,889
(4) Other charges .	503	2,029	1,737	1,532	14,083	204	21,808
Total A.—Conservancy, Maintenance and Regeneration.	9,434	4,768	5,488	4,460	30,516	3,169	65,834

APPENDIX IV—*contd.*

ANNUAL FORM NO. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure of the Branches during 1933-34—contd.

Budget Heads	Direction.	Silviculture Branch	Botany Branch.	Entomology Branch	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
EXPENDITURE—*contd.*	Rs.	Rs.	Rs.	Rs.	Rs	Rs.	Rs.
B.—Establishments—							
I.—Pay of Officers—							
Non-voted—							
(a) Conservators . .	..	..	..	..	.	..	..
(b) Superior officers .	13,218	15,196	..	30,315	16,893	..	75,622
Voted— Superior officers . .	237	15,297	20,122	1,,180	91,778	21,351	1,72,077
II.—Pay of Establishment—							
Pay of establishments .	26,166	30,700	10,610	25,707	97,078	5,572	1,94,733
III.—Allowances—							
Cost of passage (Central)—							
Non-voted . . .	..	..	..	..	..	..	..
(b) House-rent and other allowances—							
Non-voted . . .	..	..	..	..	..	..	..
Voted	505	..	..	..	..	..	505
Travelling allowances—							
(c) Conservators, Non-voted	..	..	..	..	..	..	..
(d) Superior officers—							
Non-voted . . .	127	2,338	..	2,015	429	..	5,339
Voted	..	1,155	1,017	1,222	7,241	051	11,886
(e) Subordinate forest and depot establishments.	..	128	110	750	..	..	988
(f) Office establishments .	...	1,060	339	1,422	320	..	3,135
Cost of passage to America of officers for training etc.	...	..	..			..	..
IV.—Contingencies—							
(a) Stationery .	3182	114	30	..	..	..	328
(b) Carriage of postals and tents.	..	180	218	118	11	..	1,160
(c) Rents, rates and taxes	2922	181	720	..	10	..	1,572

APPENDIX IV—*concld.*

ANNUAL FORM No. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure of the Branches during 1933-34—concld.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*concld.*							
(*d*) Pay of menials . .	..	..	..	..	..	..	..
(*e*) Official postage . .	803	425	672	306	487	51	2,804
(*f*) Sundries . . .	19,932	1,163	808	1,357	1,242	808	25,460
(*g*) Clothing and uniform .	217	46	26	35	332	28	684
(*h*) Telephone . . .	620	266	272	238	1,446	52	2,903
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-voted).	600	600	..	..	600	..	1,800
Payment on account of medical treatment	..	..	..	..	..	..	..
Total B.—Establishments .	64,328	59,151	44,828	70,084	2,16,478	28,576	4,91,895
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	73,761	63,919	49,816	83,494	2,52,994	31,715	5,55,729
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	..	..	..	1,785	505	..	2,290
Surplus or deficit . .	—71,457	—63,692	—49,802	—85,257	—2,50,301	—31,715	—5,52,254

NOTE.—The figures given in this statement have been prepared in the President's Office and are based on the Summary of Revenue and Expenditure for March 1934 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

C. G. TREVOR,

President,

Forest Research Institute and College.

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